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STANDARDIZATION VERSUS MEDICAL EDUCATION[1]

By Dr. CHARLES R. STOCKARD

CORNELL UNIVERSITY MEDICAL COLLEGE

THE very agreeable task has fallen upon me to welcome you here to-day. When welcoming strangers, newcomers or initiates into one's castle or into one's clan it seems to me both cordial and fair to openly consider what manner of place it is to which you are being welcomed and to presume something as to why you seek welcome here. The simple tone of welcome does not always indicate the kind of consequences to follow—some of you may recall the very gracefully poetic invitation of the spider to the fly.

This place is one of those ancient human arrangements in which a group of somewhat mentally mature and experienced persons undertakes to encourage and lead a larger group of youthful aspirants into the knowledge and methods of a learned profession. This kind of arrangement has been jealously perpetuated throughout the generations of human history to be handed down to us. It has been accepted as necessary in the existence of tribes, kingdoms, empires and free states. And it belongs to that order of things commonly called schools.

All of you have had far beyond the average experience in schools, and in this place you are not altogether strangers. But have you stopped on the threshold to ask yourselves what differences there are between this place and the schools you have already attended—and, more important still, what are the different reasons for your having been in the different grades of schools? All schools are not alike and we attend each for a different reason to ourselves and to the state.

Attendance in the elementary school is compulsory and is demanded by almost all enlightened governments. The state requires and supplies a certain amount of education. But, as in the case of most things forced upon us, the child frequently assumes that he is attending school for the state or the law or surely for some one other than himself. In the ele-

[1] Address delivered at the opening of the session of Cornell University Medical College, New York City, on September 29, 1930.

mentary school and our high school learning is a forced performance and the idea in the mind of the pupil is that he is studying and working for the accommodation of the teacher. If he likes the teacher he studies and, if not, he avoids it. The teacher is often heartily disliked and learning is an arduous imposition.

Our American colleges are quite different in many ways from the elementary schools. Attendance in college is not required by the state. Yet most of the states have recognized that this is a degree of education which should be available for those citizens who desire it, and many states of the Union maintain colleges where such education may be had without cost for tuition. However, no state has seen fit to require or force the college attendance.

The college is thus presented as an opportunity to be freely chosen—a luxury in education. In spite of this fact a carry-over from the compulsion of the elementary system, together with the urge of the pretentious parent desiring a college attendance for his immature son, keeps alive the early attitude that education is taken for the good of the state, the pride of the parent or something other than the high advantage to the student himself.

In speaking of college education I am timidly referring only to that precious but inconspicuous and almost submerged effort for academic learning, and not the booming rah-rah spirit and intercollegiate athletic mania so out of proportion and out of harmony with any intellectual pursuit.

Finally, after finishing college as the highest of the preliminary educational experiences the person is faced with the problem of employing himself in the community. He feels the need of a knowledge of how to do something! He learns that there are professional schools for the higher activities of engineering, art and music, and schools for theology, law and medicine—the so-called learned professions. No state forces on its citizenry an education in such schools. Very few, if any, states provide such education free of some tuitional cost to the student. Few ever so haughty parents attempt to force this class of education on their resistant sons.

These professional schools along with the departments of pure science and scholarly research constitute the universities or institutions of higher learning. In such places as these the atmosphere, by which one may mean the attitudes of teacher and pupil, should become entirely changed from that of the elementary grades.

The pupil is no longer impounded by the state or forced by the parent to do this task, and the teacher is no longer the officer of the state or the agent of the parent to see that the task is done. Now at last the student is an independent individual forced by no one to seek an education preparatory for his life profession. The teacher now becomes a dependable and encouraging worker associated with the student. Such a teacher should be an established scholar and investigator in his own field with an impulse to lead and direct the activities of less experienced students who have an aim to function in ways related to the teacher's intellectual interests. These teachers must lend themselves to be a source of inspiration to their students. They are often men of eminent distinction in science and learning and of international reputation in their sphere but at the same time without possessing even local notoriety. The man on the sidewalk has never heard of them. It is this contrast between the attainment of actual distinction and the craving for ordinary notoriety that sets the scholar apart from the "movie-star."

The scholar is self-sufficient. He need never be lonely and is never idle. The notoriety seeker is dependent upon the crowd—alone he is completely insufficient and out of the sight of others he is generally idle.

The true university in all its branches is the haven of scholars. They alone are at home here, and no one else is altogether comfortable. The place is inspiring and every one strives to take advantage of its privileges which so few of the human inhabitants of this globe are capable of enjoying. Let us hope and be bold to trust that this school is a part of such a university.

So much then for the nature of the place in which we gather to-day.

We may now become more specific in a brief consideration of the recent conditions in the American medical school. During the first decade of this century, only between twenty and thirty years ago, there was no crowding excess of students in our colleges or medical schools. On the contrary, members of the faculty frequently spent parts of their summers in traveling around drumming for students. The graduate schools of the universities at times offered more scholarships and fellowships than could be filled even after seeking for applicants.

The medical schools were fully developed in only a few places. Most of them were far behind in facilities and inadequately organized. The poorer ones drew students more easily than the better ones and all spent time and effort in trying to persuade students to come. There were very few requirements for entrance and almost any one could be admitted. This medical college accepted high-school graduates and took all comers, as did almost all others, and had classes of something less than a hundred students.

The medical schools and colleges before 1914 were

open and almost unregulated and so was travel and general behavior. It was an unstandardized and unregulated period.

Some medical colleges required one thing and some another and many had no connection with a university or a general educational institution at all. These stood alone as a weed in a desert and wrote diplomas in their own name as acceptable documents in the community. Any one could attend, and almost any group of doctors could conduct a medical school.

During this same time any one who had it could fill his purse with the coinage of almost any country, board a ship and sail away to almost any port without a passport, without a letter of credit and without any questions as to where he was going.

Any one during this time could walk into a grocery store or a wine store and order whiskey, wine or beer by the bottle, case or carload and it would be simply delivered at his home with no more question or surprise than is the delivery of a pound of coffee nowadays.

And all these ways in education, travel and barter were the general fashions less than twenty years ago!

But do not imagine for a moment that this was a time of pandemonium—quite the contrary. It was merely the time before organizations assumed an extensive responsibility for personal behavior. Drunkenness was little if any worse than now, particularly among the respectable classes; crime was modest and shy, and there was no occasion for a government commission to study the violations of law. There was also no exalted commission on medical education.

Under such conditions what was the state of mind of the medical students? Naturally it was rather free. They had come to the medical school because they wanted to and were interested in being a physician or a surgeon or a medical scientist. Certainly they did not come because it was the fashion or the thing to do, for it wasn't. Whether they attended all classes or how much work they did was no one's worry. When the time came students were given an examination and often as high as 30 to 40 per cent. of the class would fail. Those who failed simply repeated the course for the next year or so until they passed or else they left for some other school that asked few if any questions and was glad to have them.

This state of affairs was not altogether so bad as it sounds, for there were good medical schools as well as bad ones and many good students were in all of them. These men to-day are a credit to the very top of their profession in various lines.

What the situation very evidently needed was a little brushing upward and many influences began to work toward tearing the bottom off in some cases and pushing it up in others. This started well and within the short space of a few years between 1909 and 1915 almost all the actually harmful and unfit medical schools of the country were closed and out of business.

This surprising result was largely due to a masterly survey and discussion of American medical education by one able man. However, the fine start, as is often the case, obtained a bit too much momentum and swept out into the national organizations and committees. These became very busy but only succeeded in bringing about the present-day fashionable craze of standardization and regulation of all thought and fancy in medical education.

The Association of American Medical Colleges assumed new importance. The council on medical education of the American Medical Association began to flourish as never before. An epidemic of curricula prescription writing swept the country's map. A certain dose of so many hours was prescribed for all growing medical students in anatomy, chemistry, physiology, pathology and even in medicine and surgery. There was generally a minimum and maximum dose allowed, depending perhaps upon the constitution of the school and the maturity of the student.

It was not realized that getting rid of disgracefully bad and inadequate schools was one thing which need not inflict any regulation whatever on the composition and performance of the best schools.

Finally, the medical schools have reached back into the college to require a definite premedical training of so many units in biology and physics, chemistry, etc. The number of college units of credit is naturally easily calculated, and the units are what count rather than the more difficultly ascertained quality of experience and inspiration which the college education has imparted.

Having secured the premedical requirements a vast number of students now apply for admission into the sanctum of the medical school which to them seems quite formidably guarded. Nearly a thousand persons apply for the privilege of being the seventy to constitute the first-year medical class. The selection is rigid and all must pass muster on their school records, their premedical units, their personality and other qualities. Finally, the door is open to the selected few and they enter in with fear and trembling lest they once fail to pass a few courses and are dropped out, never to have a second trial, and with slender prospect of being taken into another fold. Under these conditions every one does not work merely for the joy of learning but oftimes only for the necessity of passing. The course becomes a

crowded grind and the inspiration and glory of simply doing becomes a faraway phantom.

The course is often regulated and standardized to such an extent that every one is trying to do exactly the same thing in the same time and to beat the other at doing it. This is irrespective of individual tastes, talents and personalities. These various personalities are swamped in the uniformity of things, and intellectual tolerance and truth are difficult to hold in the spotlight of advance. This is contrary to nature and so peculiar situations have arisen. One of these I may relate as having occurred in a far distant part of the country.

A medical school conducted along the usually regulated plan found that cheating on examinations had become a rather general and accepted practice among the students in spite of the existence in the school of the so-called honor system. The faculty became disturbed on realizing that things were not exactly as they were ruled to be. The dean of the faculty conferred with a group of the senior students to discuss the situation. He learned that the students agreed that if all those who cared to should cheat it would be as fair for one as for another, and the sad predicament of being dropped from the school might be avoided by some and reduced to a helpless minimum.

The dean was somewhat surprised at this rather broad and philosophic attitude, but he felt that the students were chiefly at fault. He propounded a further question as to their plan of behavior and asked whether they, who had decided cheating was proper, would steal another's instruments or clothing. The students replied that none of them would steal, and they held stealing to be a crime. The dean and students acquiesced in the idea that stealing was a greater vice than cheating or lying.

This of course was surprising to members of a scientific group, who had come to realize that truth was the supreme virtue towards which all students of natural science must aspire. Questions of ownership and property rights are social and artificial, and changes in the system cause no mental confusion. We know exactly what has occurred and what we have. One person had in his possession a material thing which another person has temporarily taken for his own. But when one relates an occurrence or records an observation as having been other than it truly was we are misled and mentally confused. If this was a general practice we could scarcely become acquainted with the world about us. In medical science as in all science there must be a never-failing search for fact or truth. One must depend upon the truthfulness of others in order to advance knowledge in the conquest against disease.

If an experimental investigator reports a given drug to bring forth a definite physiological response which might be of high clinical importance, the clinician must depend upon the truth of the report and if it be false it may mean the death of his patient. Persons who must in practice apply truths and facts as they are given to them are not the people to tamper with deception and falsehood during their years of education and training.

We must now ask ourselves whether a system of standardized regulation does promote a search for truth and does really enthrone truth among its gods.

When a number of persons, all differing in their past experiences, tastes, knowledge and desires, are forced into a system demanding a uniform performance they intuitively feel the contrariness to natural truth in the plan. Individuality is embarrassed and originality is discouraged and the routine of the machine is glorified. This promotes cheating and finally, as we have seen, may carry the vice through the stages of endurance, pity and embrace.

When cheating becomes general it is the fault of the situation and not alone of the persons concerned. If this be a situation in scientific education it must be promptly changed and made over or the aim for which the system was intended will be forever lost.

The student comes to the medical school as an adult individual to work for himself and to learn his own job. His behavior should be regulated by the system as little as possible and he should be given every proper opportunity to use his own initiative, his own discretion and his own way in securing for himself the knowledge and skill he needs in his profession. If the opportunity for free action and choice be completely denied him by a system of standardized uniformity how can it ever be expected that this person will later be original, resourceful and ingenious in the handling of human patients or the solving of medical problems? It is as much a part of education, and especially of higher education, to learn how to direct one's self independently as to accumulate knowledge from laboratories and books.

Lectures, demonstrations, laboratories and clinics should be available, but only the most formal part of these should be scheduled by time. A student should be free to work as short or as long a time as he finds necessary for an understanding of the particular problem or subject. Certainly no two intelligent individuals can quite do the same thing equally well in exactly the same time. A student should, therefore, have some right in deciding when he is ready to be examined for qualification in a subject. All this latitude is perfectly possible and is being practiced in parts of the university and to some extent in medical schools in several parts of the world.

Some one may say that many students are not adapted to such open arrangements as this—I agree that they are not, but I would also add that they have no business here and the community would be indebted to us if such persons were unable to crawl into the medical profession. No one should be carefully checked for attendance, quizzed and drilled on lectures and texts and watchfully guided through laboratories and clinics for four years, and then be suddenly let go to stand on his own feet and independently treat the sick and dying.

The champions of fairness to the weak and deficient student have had far too much influence in the moulding of methods and arrangements in the medical faculties. This vision of fairness should be a little more far-sighted and look away to the lame doctor attempting to treat the crippled patient at the other end of the line. There might be a picture hung beside the rear exit door of a medical school showing a bungling, inefficient person pretending to cure a sick patient, and for those admiring symmetrical hangings an appropriate sister painting could portray the proverbial blind leading the blind.

No, there can be no welcome here for bungling, sloppy-minded or incapable persons—the medical college is not the place for them. And a consideration of such persons should not enter into the design of our educational policy. The policy must consistently avoid penalizing the able student in order to salvage the unable; it must be built only for him who stands.

We do not propose a simple turn-back to the old open system of ante-bellum days which so many of us experienced. This would get us no further along. But we do urge as the essential elements in human education open-mindedness and intellectual tolerance. Education in all fields of science should break down prejudices, promote tolerance and force with unerring determination the quest for natural truth. This has never been approached on any system of standardization. Uniformity and standardization immediately establish a prejudice against deviation and false ideas of perfection arise. Tolerance and truth have little sanctity in such a communion.

We here have aimed to have an institution in which an understanding of life may grow. The consideration of facts as we know them and the search for new facts is to be our daily privilege. To differentiate fact from fancy and to become adamantine in our determination to make no mistake between them is to be our discipline. Human minds frequently accept wide categories of things as facts. But the free admission of half-established findings to the realm of facts is the most befogging reaction of the brain. The more cautious one becomes in accepting an apparent fact the more reliable he becomes as a scientific scholar.

The struggle for truth must be consistent and universal. And self-deception must be as fully and as carefully avoided as the deception of others. No one can deceive himself without sacrificing his only method for obtaining the truth.

To these aims and to your part in their accomplishment the faculty of Cornell Medical College heartily welcomes you!

HOW THE COLLEGE CAN AID THE OYSTER INDUSTRIES[1]

By Dr. DONALD W. DAVIS

PROFESSOR OF BIOLOGY, COLLEGE OF WILLIAM AND MARY

The story is told of Alexander the Great that as a young man he watched the efforts of his father's subjects to tame an exceptionally fine horse, and noticing that the horse shied at its shadow and obtaining permission to attempt to ride him he faced Bucephalus toward the sun and forthwith had him under full control. The obvious moral to this tale for the two organizations meeting here to-day is "know your oyster." It is possible that some of the many unexplained difficulties encountered by the oysterman are due to the oyster shying at its shadow, and only an observant Alexander is required to orient him properly. But, unfortunately perhaps, the oyster in the earlier stages of its life cycle is very small and elusive, difficult to find and to see without special aids. Furthermore, the source of the shadows interfering with our control of the behavior of the oyster are obscure. Its food is exceedingly minute, and the physical and chemical balance in its surroundings necessary for its complete and rapid development is most delicate. So that knowing your oyster adequately for satisfactory control requires use of the microscope, the test-tube, the salinometer, the balance, the kymograph and most of the rest of the physical, chemical and biological equipment of our biological laboratories. It requires also the mind trained in interpreting the revelations of these aids

[1] Read before the annual convention of the National Shellfisheries Association, Sayville, Long Island, August 19, 1930.

to our senses. I do not wish to suggest that such a personality as that of Alexander the Great is required to solve our problems and to apply the knowledge thus acquired to the business of oyster production. Barring the few who have defects of eye or hand or mind that positively and seriously interfere with the use of one or more of these instruments in the prosecution of observations or experiments, any member of this audience can train himself to do this work if he has the will and the time to do so. That is, by and large any member of this group may if he will qualify himself as a biologist for the study of oyster problems. In doing so he will study physics and chemistry, the structure and behavior of the oyster and its relatives, its food and its enemies; he will need to practice in the use of the experimental method and its tools. In a word, he will find it necessary to go through just such a program of rigorous training as is provided in our schools and colleges for the training of young men for scientific work in various fields. I would not be so foolish as to urge that every member of the organizations meeting here make this attempt. Actually and for numerous good reasons very few will do so. Obviously, for most of those present the important thing is to see and to know the work of the biologist sufficiently to utilize the particular skill he has acquired in the solution of problems to which that skill is requisite.

The problems to which the biologist interested in oyster production addresses himself are of three kinds. One is that of original discovery, of research, finding new significant aspects of the life history of the oyster or of its food or of its enemies or of the relations to other features of the environment. This is comparable with the discovery of new processes in a chemical industry on which modifications of procedures may be based. Studies of this sort make possible profitable application in regions far from the place where the research was done. Another kind of problem is concerned with adaptation of the results of fundamental research to local situations. A few bushels of experimental demonstrations may save boatloads of losses. This type of study involves much the same methods as the first and leads to further research of the first type. It also points toward the third type of study. This may be referred to as control study, routine tests of conditions for which standard procedures have been established by studies of the preceding types. These tests should be made as widely as possible in oyster-producing areas as checks on established methods and as guides to current local practice. These tests also may lead to further studies of the other types. Parenthetically it may be readily admitted that oysters may be produced with profit without such services as I have indicated. We all know of persons who are successful in various activities in spite of their disregard of modern aids and methods—from the sailor who senses his channels and needs no buoys or lights to the cook who skilfully judges the amount of various ingredients and scorns to weigh or to measure. But the number who develop such skill is too small for present demands, and the losses by these methods from the failures of the less competent are too great for our times. We are committed rightfully to the plan of marking our channels and providing our kitchens with scales and measures. Surely the oyster industry is not one to be exempt from the need of such aids. Judgment is, and will always be, a most important factor in oystering. The work of the biologist in the oyster industry is not to render judgment unnecessary but to provide a significant basis of information on which more reliable judgment may be based.

It seems clear, then, that in oyster production there are unsolved general problems and local situations requiring investigation and control by men trained in the use of scientific methods. The function of the college and the university in conducting such studies and in training men for such work is better recognized in some other industries, but that they have their part in our industry is unquestionable. The presence on this program of papers presenting results of just such studies as I have suggested by men working at universities or trained in them and the presence of other speakers representing institutions noted for their contributions to this and other industries abundantly evidence the aid these institutions may give to the oyster industry. Lest I do injustice by omission or emphasis in the more complex situation within our industry let me cite by way of illustration of the closeness of the universities to industrial investigations the series of studies on fresh-water mussels. Some of you doubtless heard M. M. Ellis review this series before the American Fisheries Society a year ago in Minneapolis, and others have read his address published in the *Transactions* of that society. In 1866 the German zoologist, F. Leidig, then at Tübingen University, demonstrated that larvae of the fresh-water mussel live parasitically on the gills of certain fishes. Lefevre and Curtis, of the University of Missouri, artificially infected fishes with mussel larvae. Arey, of Northwestern University, studied the relation of the larvae to the tissues of the host. Now Ellis, of the University of Missouri, carrying further the series of investigations, has succeeded in raising mussels without intervention of the troublesome fish host and has given new promise to a seriously depressed industry. These men are all university trained and all have carried on their work while

serving in a university connection. It would be unfair as well as ungracious to fail to mention in this connection the essential part played by the U. S. Bureau of Fisheries in these studies. If I am not mistaken all except one of the American investigators mentioned has carried on his mussel work under part-time appointment of the bureau. The stimulating and coordinating function of this and other agencies outside of the academic institutions as well as their function in actual conduct of investigations must be fully recognized.

It is not my purpose here to discuss in detail the part to be played by different agencies in promoting the studies suggested. Some may best be prosecuted by the colleges or universities or by men in their services. In other cases it is better that governmental agencies directly employ investigators, while more and more it is to be expected that those engaged commercially in the industry will cooperatively or individually find it to their advantage to employ full-time men on their particular problems. Examples of all these methods are familiar to you all, and selection of a favorable relation for any particular need and budget possibilities should not be difficult. In presenting the possibilities of usefulness to the oyster industry of the colleges and universities I should, however, point out certain advantages of having researches in the interest of the oyster industry in close touch with college or university. In the first place, in these institutions much in the way of overhead expense is already taken care of and need not be a charge on the investigation; much equipment is already supplied and much in the way of advisory and consultative service in various departments is available at little or no cost. Again, the service of student apprentices or assistants can usually be obtained at small expense. By such relations the institutions are stimulated to offer courses needed for improved training of these assistants and of others whose interest is stirred by their work. These intimate relations result not only in more and better trained men in general but trained men with some interest and acquaintance in the specific problems of the industry. I think it is not too far afield to claim even that there is actual if not measurable advantage to the industry through contacts of those interested in it with those in the colleges not otherwise in touch with this particular industry. The oyster industry has often suffered from the lack of sympathetic acquaintance on the part of those, constituting the great majority of the citizenship of the state, who live beyond the limits of tidewater. Anything that contributes, as I maintain the college and university do when carrying out studies in association with a great industry, to dissemination of a sympathetic interest and acquaintance with its problems is far from negligible. I believe many of us could testify as to the broadening effect on our interest and sympathies of such college and university contacts.

Now while I recognize well that the independent spirit of those in the oyster industry makes the suggestion peculiarly little needed, it may avoid misunderstanding in some quarters for me to point out that the undertaking of studies of value to the oyster industry by academic institutions or by men in their service is usually possible only when agencies concerned in the industry contribute more or less of the expense of the investigation. The colleges and universities already have a full program, and their staffs are in general well loaded with previous undertakings. If those engaged in an industry themselves recognize no need of services from these institutions, that industry stands small chance of having the institutions or individuals belonging to them, unasked, step in to formulate and solve their problems or to set specifically about training those who will. The relation is one dependent for success upon close cooperation and a pooling of facilities and resources in order to accomplish objects of value from the standpoint of both industry and education.

But in listing the offerings of academic institutions to the oyster industry, I should not confine myself to that large phase of the industry concerned with production. Rapid advances in means of distribution, in methods of preservation, packaging and handling have brought into prominence problems connected with these aspects of the industry, and here too specialists for investigation and control are demanded. For these too the colleges have provided fundamentally trained men. They will doubtless be called upon to supply technologists more fully trained and in greater numbers in the future.

With the increase in size of the units engaged in production and distribution, with closer cooperation among the units concerned and with heightened interest of the state and national governments in stimulating and coordinating the activities of this and related industries, the demand for qualified administrators is advancing. The trained administrator (whether trained wholly in service or in part in an academic institution) is one who, while not necessarily skilled in the various techniques, is broadly acquainted with the methods in use and with their possibilities of development, familiar with types of organization and with business procedures. Various elements in this training are now given in the colleges. Coordination and extension of the training along this line may be accomplished.

Various limitations prevent my taking up in detail the academic facilities for training men along the

lines mentioned, but, in closing, I want to make one further suggestion. Young men already possessing close acquaintance with oyster industries are going to college and on into graduate work of the universities. Other things being equal, they start with great advantage over other men who may take the training I have mentioned as marine biologists, technologists or administrators in the oyster industry. I believe that they may well plan to get in college and in the university, among other objects of their desire, knowledge and training of special significance to them in connection with a life devoted to the commercial oyster industry. Let us have in the institutions as much as may be of your problems to set before the young fellows who will go into the oyster industry. For success in the future, they must go into various aspects of the business equipped to see deeper than oystermen have seen, to know more fully than they have known. Give these fellows the best that practical oystermen can give them and send them to college with the will to see and to know—and among us we'll make another generation of real oystermen.

OBITUARY

RECENT DEATHS

DR. HERBERT H. DOW, president of the Dow Chemical Company at Midland, Michigan, died at the Mayo Clinic on October 15, at the age of sixty-four years.

DR. HENDRIK ZWAARDEMAKER, professor emeritus of physiology at Utrecht, died on September 19, at the age of seventy-three years.

ALEKSY ALEKSANDROVIC KULJABKO, professor of industrial physiology, died at Moscow on August 6.

MEMORIALS

THE forty-fifth annual convention of Tau Beta Pi, engineering fraternity, in session at Lehigh University on October 11 dedicated a memorial to Dr. Edward H. Williams, Jr., its founder. This marks the forty-fifth anniversary of the founding of the fraternity at Lehigh in 1885. Dr. Williams was professor of mining engineering and geology at Lehigh when he founded the organization, retiring several years ago. The memorial, which will consist of a bowlder with a bronze tablet, will be placed in front of Williams Hall on the campus, which building was the gift of Professor Williams many years ago.

AT Colgate University the new chemical laboratory, built at a cost of $500,000, will be dedicated on October 31 and November 1. Funds for the erection of the building which is named in honor of Professor Joseph F. McGregory came from Dr. James C. Colgate, chairman of the board, and from the estate of Miss Evelyn Colgate. For forty-three years Professor McGregory was head of the chemistry department at Colgate.

IN memory of the late Stephen T. Mather, first director of the National Park Service, an oak tree was planted at the old Mather homestead at Darien, Connecticut, on October 19. Planting of trees in honor of Mr. Mather has been carried on throughout the country, singly and in groves, in widely separated portions of the country. One memorial forest of 10,000 trees was planted by the State of New York. In each of the national parks a single memorial tree was planted on July 4, Mr. Mather's birthday, by uniformed park rangers. Plans are also under way for plantings in the southern states when weather conditions are most favorable.

THE *Journal* of the American Medical Association notes that a group of physicians of the region about Pau (Basses-Pyrénées) celebrated recently, in that city, the memory of their compatriot, Dr. Duboué, and had affixed to his home a tablet setting forth the stages of his career. The ceremonies were presided over by Dr. Doléris, member of the Academy of Medicine and a native of this region. He recalled that Duboué, in addition to his research on typhoid and cholera, had been the first to discover that the virus of rabies finds its way from the initial wound to the brain by way of the nerves and not through the blood stream. His work was published in 1879. It was two years later that Pasteur read to the academy his own work on rabies, in which he recognized the priority of Duboué.

SCIENTIFIC EVENTS

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE British Association for the Advancement of Science has recently concluded a most successful meeting at Bristol, at which discussion has taken place as to the arrangements for the centenary meeting, to be held in London, with the gracious approval of H. M. the King, patron of the association, and under the presidency of General Smuts.

The association during its first century of existence may claim to have established itself, first as a national and more lately as an imperial institution. Its council is of opinion that, despite the steady support which it receives from its members, and the generosity

of certain individual benefactors, and of those home cities or dominions which from time to time entertain it for its annual meetings, the power the association has acquired for the advancement of science might be far more effectively exercised if it possessed a larger endowment. The council would be loath to risk narrowing the present wide field of membership and therefore of interest and usefulness by increasing the subscription for the annual meeting, though that still remains at the figure of one pound at which it was fixed in 1831, and has even been recently reduced to half that sum for junior student members. The council has therefore decided to appeal for a centenary fund of £40,000.

A first charge upon that fund or the income from it must be the expenditure appropriate to the fitting celebration of the centenary itself. In this connection it is the object of the council to make the centenary meeting an occasion for the gathering of the largest possible representative body of scientific workers from the dominions, and by this means to repay something of the debt which the association owes to those dominions whose hospitality its members have enjoyed.

Beyond this immediate object the association earnestly desires to maintain and extend its annual financial support of scientific research, to discharge fittingly the trusteeship of Darwin's house at Downe, recently entrusted to it in custody for the nation and indeed for the civilized world, and to assure the means of carrying out its imperial responsibilities. Its financial constitution has always forced it to live in a measure from hand to mouth.

The contributions towards research from the funds of the association fluctuate annually with its net balance of receipts over expenditure, and it is therefore often a matter of chance whether the association is able to support any particular research in accordance with its intrinsic importance. Not infrequently the association has to count the cost, with too much appearance of parsimony, before accepting an invitation to a particular place, having regard to the prospects of local support, or to the distance and expense involved for members who attend. Where the association is summoned to carry on its public mission, there the council feels that it should be able to go without question or limitation on financial grounds.

Those who serve the association by contributing to its program, carrying out its researches and organizing its reception at successive places of meeting, do so voluntarily, and it has been said that to voluntary service in the interests of science the whole story of the British Association stands as one great memorial. The object of the present appeal is to strengthen the organization which makes use of that service.

Contributions to the centenary fund will be gratefully acknowledged by the General Treasurer, British Association, Burlington House, London, W.1, and it is competent for donors to hypothecate their contributions, if they so desire, for research in any particular department of science or for any of the objects which have been indicated above.

F. O. BOWER, *President*
J. C. STAMP, *Hon. General Treasurer*
JOHN L. MYRES, } *Hon. General Secretaries*
F. J. M. STRATTON, }
O. J. R. HOWARTH, *Secretary*

THE BRITISH PARASITE LABORATORY

THE London *Times* reports that delegates from twenty-two British Empire countries who attended the Imperial Entomological Conference visited the Farnham Royal Parasite Laboratory, Buckinghamshire, which was founded by the Imperial Bureau of Entomology in 1927, by means of a grant from the Empire Marketing Board, to further the control of insect pests by the biological method. The visit gains topical interest by the publication of "The Biological Control of Insect and Plant Pests," which contains the first full account of the work at Farnham Royal.

The "Parasite Zoo," as the laboratory has been called, is a converted country house used as a clearing station and breeding center for "beneficial" insects. These are dispatched to the Dominions and Colonies to attack the pests which cause enormous loss to plant and animal life. The good insects are parasites, and control the bad insects by laying their eggs in or on the pest's grubs and eggs, and then by feeding on them. In the three years of its existence the laboratory has been asked by Dominion and Colonial Governments to investigate some seventy different kinds of insect and weed pests in the hopes that parasites might be found.

It is estimated that blowflies annually destroy about 5 per cent. of the sheep of Queensland, and cost Australia £4,000,000 a year. The wheat stem sawfly did £2,500,000 worth of damage in 1926 in one province alone. America suffers so severely that a sum of £2,000,000 was recently spent by the government in one year in an effort to check the advance of a single insect, the European corn borer. This borer is now advancing into Canada. The United States has recently spent £12,000,000 in fighting five insects.

The report describes some curious devices invented by entomologists. One of these is called a "bouncing machine." Insect eggs are made to roll down a wooden chute and bounce off a small piece of tin at the bottom. An egg which has been parasitized—that is, which has another egg, laid by the parasite, inside it—has not the same capacity for bouncing as have

healthy eggs, which jump into a further tin, and so are separated for laboratory purposes.

Shipments of some twenty different kinds of insects have been sent overseas, generally in cold storage, in special cases with food, such as raisins or sugar and water, for rations. Fourteen consignments of a parasite which attacks woolly aphis—a serious apple-tree pest—have been distributed in England, India and Kenya Colony. This has practically exterminated woolly aphis in New Zealand. Parasites of the wheat stem sawfly, the whitefly and the pine shoot moth have gone to Canada; one which attacks the sheep blowfly has been shipped in large quantities to Australia and South Africa; a Californian ladybird has gone to Madras; a miniature wasp which eats the pear slug has gone to New Zealand and a bollworm to the Barbados. In all, a total of about 58 shipments, comprising some 100,000 specimens, have been shipped from the laboratory to various parts of the Empire.

THE IRON ALLOYS COMMITTEE OF THE ENGINEERING FOUNDATION

A SUMMARY of world progress in the field of iron alloys, advance in which is held to be fundamental for American industry, is the object of a program of research enlisting the cooperation of more than sixty industrial and scientific organizations and corporations of the United States under the leadership of the Engineering Foundation.

A fund of $230,000 to make possible a review of all available literature has been contributed by the cooperating organizations, among which are the American Foundrymen's Association, the Battelle Memorial Institute of Columbus, Ohio, and approximately fifty companies producing or using steel and iron. Universities and technical schools, foreign agencies and bureaus of the United States Government are aiding the project, in which the Engineering Foundation has the active assistance of the American Institute of Mining and Metallurgical Engineers and the American Iron and Steel Institute. The American Society of Mechanical Engineers, American Society of Civil Engineers and American Institute of Electrical Engineers also are cooperating.

The scope of the investigation, which is described as the most ambitious ever undertaken in this field, was outlined by an advisory committee headed by Dr. John Johnston, director of research and technology of the United States Steel Corporation. Supervision of the program, which will require five years for completion, has been delegated to an Iron Alloys Committee, of which Dr. George B. Waterhouse, professor of metallurgy in the Massachusetts Institute of Technology, is chairman.

As its initial task, the foundation and its cooperating organizations are conducting a critical review of all available literature in English and other languages. Coincident with this review, two lines of original research into iron alloys have been initiated. Others will be taken up later as the need for them is revealed by the critical examination of the very extensive literature.

Underlying the plans of the foundation and its associated bodies is the growing necessity for condensed, dependable statements in convenient, classified reference books, of the basic information upon which the future advancement of the iron and steel industry may be built. World competition and increasing demands upon production are expanding the need for research which will keep the United States abreast of progress in the field of iron and steel alloys.

The critical examination of scientific and trade journals and books published during the last forty years in all parts of the world is the first step being taken by the committee. Much progress has been accomplished. A list has been made of approximately 2,000 journals in ten languages, containing information of all kinds on iron and its combinations with other substances, the announcement says. This list is believed to be very nearly complete for all periodicals which have been published for any period since 1890 in twenty-five countries. Books will also be included in the review.

The portion of the enterprise now in hand is searching the literature for information on thirty-nine elements and compounds in twenty-three separate classifications, making a total of more than 800 classifications.

With the cooperation of Lehigh University, a study of the combinations of iron with silicon was begun under the direction of Mr. Bradley Stoughton, professor of metallurgy, who brought to the Engineering Foundation the suggestion that has been expanded into the Alloys of Iron Research. The review of the literature has been nearly completed, a bibliography prepared, some laboratory research done and a monograph drafted.

A grant was made to the Carnegie Institute of Technology to assist a research in the combination of iron with manganese by V. N. Krivibok, associate professor of metallurgy, and associates under the direction of Francis M. Walters, Jr., director of the Bureau of Metallurgical Research. Important results have been achieved in the laboratory, and progress has been made upon a review of the literature. These two projects have proved fruitful not only in information on their subjects, but also in guidance to the committee in devising methods for the whole enterprise.

Through a form designed to expedite abstracting, all the information gathered on each one of hundreds of subjects can be readily assembled. As the review of literature progresses there is being built up a valuable body of reference material on which may be based later a service of great convenience to persons preparing programs for research, patent claims, papers for technical societies and for other purposes. More than 3,000 abstracts have already been made and filed.

The Engineering Foundation has the cordial cooperation of the American Institute of Mining and Metallurgical Engineers and other societies of engineers; the American Iron and Steel Institute, American Foundrymen's Association, Battelle Memorial Institute, Columbus, Ohio; Carnegie Institute of Technology, Pittsburgh; Lehigh University and other universities, iron and steel companies and other industries, the National Bureau of Standards, United States Bureau of Mines, technical journals and numerous individuals. Informal assurances of foreign cooperation also have been received.

Such laboratory research as the committee undertakes will have for its aim the production of basic data which may be freely disseminated. Utilization of the data for commercial processes will be open to the industries.

DEDICATION OF THE JAMES WARD PACKARD LABORATORY AT LEHIGH UNIVERSITY

The James Ward Packard Laboratory for Electrical and Mechanical Engineering was dedicated at Lehigh University on October 15. Mr. Charles M. Schwab, chairman of the board of trustees of the Bethlehem Steel Corporation and a trustee of the university, who made the dedicatory address, paid high tribute to the late Mr. Packard, donor of the building. Dr. Charles Russ Richards, president of the university, was chairman. The architects, Messrs. T. C. Visscher and J. L. Burley, of New York City, were introduced and the former presented the keys of the building to Mr. Eugene G. Grace, president of Lehigh's board of trustees. The keys were then presented in turn to Dr. Richards, Professor F. V. Larkin, head of the department of mechanical engineering, and Professor S. S. Seyfert, acting head of the department of electrical engineering.

A two-day conference on the relations of technical schools to industry followed the dedication, at which the subjects and speakers were as follows: "What Industry Expects of the Technical Schools": F. A. Merrick, president Westinghouse Electric and Manufacturing Company; L. W. Baldwin, president Missouri Pacific Railway; A. R. Glancy, president Oakland Motor Car Company; M. S. Sloan, president Brooklyn Edison Company; Bancroft Gherardi, vice-president and chief engineer American Telephone and Telegraph Company.

"What the Technical Schools Expect of Industry": Dr. Arthur Maurice Greene, Jr., dean of the School of Engineering, Princeton; Professor Dugald Caleb Jackson, head of the department of electrical engineering at Massachusetts Institute of Technology; David Ross, president of the Ross Gear Company and president of the board of Purdue University, and Dr. William E. Wickenden, president of the Case School of Applied Science.

"The Future of Industry, its Problems and Needs": Magnus W. Alexander, president National Industrial Conference Board, New York City; "Distribution and Its Effect on Industry," Edward A. Filene, president and chairman of the board of William Filene's Sons' Company, Boston; "The Effects of Research on the Future of Industry," Dr. John Johnston, director of research, United States Steel Corporation, Kearny, New Jersey, and "The Methods of Industrial and Business Forecasting," S. L. Andrew, chief statistician, American Telephone and Telegraph Company, New York.

THE FRANKLIN INSTITUTE

Dr. Howard McClenahan, secretary of the Franklin Institute and director of the Benjamin Franklin Memorial and Franklin Institute Museum, announces that three heads of departments of the museum have been appointed. Dr. James Barnes, present professor of physics in Bryn Mawr College, has been appointed head physicist and will assume the duties of his office at the completion of his present year in Bryn Mawr. Mr. Charles E. Bonine, of the firm of consulting engineers Bonine and Costa, will serve as head of the engineering section of the scientific staff. Mr. Bonine has already taken up active work in connection with the development of engineering in the new museum. Mr. James Stokley, of Washington, D. C., a member of the staff of Science Service, will be the head of the astronomical section of the new institution. Mr. Stokley will be responsible for the operations of the planetarium section and of the astronomical observatory, as well as the outdoor observatory of the museum. These three men, together with Dr. McClenahan who is himself an electrical engineer by training and has been for some twenty-eight years a professor of physics in Princeton University, form the nucleus for the staff of the new institute. A director of the chemical section will

soon be added. Other members of the staff will be appointed as the development of the exhibits proceeds and the need for other services becomes evident.

Lectures before the Franklin Institute are announced as follows:

October 15—Dr. and Mrs. Paul H. Dike, Philadelphia, Pa. "Theremin: Theory and Practice." Dr. Dike will develop the theory of this instrument and Mrs. Dike, who is a licensed performer, will demonstrate the use of it and will give a recital upon it.

October 23—Clifford B. White, M.E., American-LaFrance and Foamite Industries, Inc., Elmira, N. Y. "Modern Fire Extinguishing Methods."

October 30—Douglas Stanley, M.S., New York City. "The Science of Voice." W. M. Jennings, Esq., Philadelphia, Pa. Display of "A New Photography."

November 6—H. H. Lester, Ph.D., research physicist, Watertown Arsenal. "The Use of X-rays in Industry."

November 13—Arthur E. Morgan, D.Sc., president of Antioch College. "The Nation's Water."

November 19—R. T. Haslam, B.S. in Eng., Standard Oil Development Company, New York City. "The Hydrogenation Process in Petroleum Refining."

December 4—J. B. Johnson, Ph.D., research physicist, Bell Telephone Laboratories, Inc., New York City. "The Cathode Ray Oscillograph."

December 10—Sir Henry W. Thornton, K.B.E., chairman of the boards of directors and president, Canadian National Railways. "Men and Industry."

December 17—Saul Dushman, Ph.D., assistant director, Research Laboratory, General Electric Company, Schenectady, New York. "Methods for the Production of High Vacua."

SCIENTIFIC NOTES AND NEWS

The Capper Medal of the National Country Life Association of $5,000 was presented to Dr. Stephen Moulton Babcock on the evening of October 10. The money and a plaque were given to him by the donor, Senator Arthur Capper, Kansas publisher, and the story of his work was recounted by Mr. Frank O. Lowden, former governor of Illinois and president of the association. Dr. Babcock, who celebrated his eighty-seventh birthday on October 22, became professor of agricultural chemistry at the University of Wisconsin in 1888 and retired as professor emeritus in 1913.

The honorary doctorate of laws was conferred at the opening session of the annual convocation of the University of the State of New York on Dr. William H. Welch, of the Johns Hopkins University. In conferring the degree Dr. Frank Pierrepont Graves, president of the university, recalled that Dr. Welch is a graduate of the medical school of Columbia University and carried on his first activities as instructor at Bellevue College of New York University. Continuing he said: "The years that bridge the interval between that first professorship and your present world-wide eminence as teacher, investigator, administrator and leader among scientists are filled with accomplishments and crowded with well-earned honors. No man has done more to make available to America the blessings of modern scientific medicine and public health work."

The degree of doctor of laws was conferred on Dr. William J. Mayo, of Rochester, Minnesota, at the recent dedication of the medical school building of Temple University.

Dr. E. P. Felt, for thirty years state entomologist at the New York State Museum at Albany previous to his retirement from the state service, has been made collaborator of the museum, in recognition of his scientific work and his cooperation with the museum. The two others previously so honored are Dr. A. P. Brigham, of Colgate University, and Professor George H. Hudson, formerly of the State Normal School, Plattsburgh, N. Y.

Dr. Ernest S. Lewis, emeritus professor of obstetrics and gynecology at the College of Medicine of Tulane University, was on September 24 the guest of honor at a luncheon given by medical colleagues celebrating his ninetieth birthday. Dr. Lewis has been connected with Tulane University for sixty years. The speaker was Dr. Rudolph Matas.

Four foreign surgeons were awarded honorary fellowships in the American College of Surgeons at the convocation on October 17, which concluded the twentieth clinical congress of the college. These were Professor Henry Wade, of Edinburgh, surgeon and urologist; Professor Otfried Foerster, Breslau, neurologist; William Ernest Miles, London, and Professor Dr. Emil von Grósz, Budapest, ophthalmologist.

Dr. Allen B. Kanavel, professor of surgery at Northwestern University, was elected president of the American College of Surgeons at the twentieth annual meeting held in Philadelphia. Dr. Rose Millar, Ottawa, and Dr. Eldridge J. Eliason, Philadelphia, were elected vice-presidents.

Professor William R. Ransom, of Tufts College, was elected president of the Bond Astronomical Club at the first meeting of the season at the Harvard Observatory.

Professor Egas Moniz on October 15 was elected

president of the International Congress of Hydrology, Climatology and Geology at Lisbon.

DR. STORRS B. BARRETT, associate professor of astrophysics, who has served as secretary and librarian of the Yerkes Observatory for the past thirty years, retired on September first under the regulations of the University of Chicago. He will continue to reside at his home adjacent to the grounds of the observatory. He was succeeded on the same date by Dr. Clifford C. Crump, formerly professor of astronomy at Ohio Wesleyan and director of the Perkins Observatory and more recently professor and chairman of the department of astronomy at the University of Minnesota.

DR. JOHN RATHBONE OLIVER, for fifteen years chief medical officer of the supreme bench of Baltimore, has resigned to accept an assistant professorship of the history of medicine at the Johns Hopkins University School of Medicine.

DR. ROGER D. BAKER, who has been during the past year assistant resident pathologist at the Johns Hopkins Hospital, has been appointed instructor in anatomy at Duke University.

AMONG recent additions to the Colgate University faculty are Mr. John A. Allen, from the University of Minnesota, who has been appointed first instructor in astronomy and who will have charge of survey work in that subject; Mr. H. M. Lake, of the University of Texas, instructor in psychology, and Mr. James Stauffer, instructor in biology.

DR. HANS F. K. GÜNTHER, known for his books on races in Europe, has been promoted to be professor of eugenics at the University of Jena.

DR. CHARLES J. STUCKY, formerly research chemist at the research laboratories of Scott and Bowne, Bloomfield, New Jersey, is now research assistant in chemistry at the New York State Psychiatric Institute and Hospital, New York City.

DR. HAROLD LEVINE, formerly chief chemist of the research laboratories of Scott and Bowne, is now research associate at the South Carolina Food Research Laboratory at Charleston, S. C., where he is in charge of nutritional investigations on animals.

DR. ERWIN W. TSCHUDI has entered the Point Breeze Works of the Western Electric Company at Baltimore as physicist-engineer.

DR. F. E. CHIDESTER, of the department of zoology, of West Virginia University, has received a grant of $500 from the National Research Council to continue his work on nutrition. This is the second grant that he has received from the council for this purpose.

ON the recommendation of its advisory council, the British Department of Scientific and Industrial Research has decided to make a senior research award for a period of three years, and of the value of £300–£350, to Mr. E. A. Stewardson, of the department of physics in the University of Liverpool.

DR. THEOBALD SMITH, of the Rockefeller Institute for Medical Research, Princeton, New Jersey, delivered the William Henry Welch Lectures under the auspices of the trustees and medical staff of the Mount Sinai Hospital, New York City, on October 17 and 18. The subjects of the lectures were: "The General Problem of Respiratory Diseases as Illumined by Comparative Data" and "A Comparative Study of Spontaneous and Induced Streptococcus Disease in the Same Species."

DR. HARLAN T. STETSON, director of the Perkins Observatory, will lecture on "Sun Spots and Radio Reception" at the meeting of the Pittsfield section of the American Institute of Electrical Engineers, on November 4.

THE Medical History Club of the College of Medicine of the University of Illinois opened its fourth season on October 15 with a lecture by Dr. W. F. Petersen on "Count Struensee." These public lectures are held in the Library of the College of Medicine on the first and third Wednesdays of each month at 1:00 P. M.

DR. GRAFTON ELLIOT SMITH, professor of anatomy in the University of London, will give two lectures at the University of California on November 18 and 19 on "Peking Men" and "The Evolution of the Human Brain."

ANNOUNCEMENT has already been made of the names of those who have accepted appointment to the George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University for the next two years. They are: First term, 1930–31, Professor G. Hevesy, University of Freiburg, Germany; Second term, 1930–31, Dr. N. V. Sidgwick, Lincoln College, Oxford, England. First term, 1931–32, Professor W. L. Bragg, University of Manchester, England; Second term, 1931–32, Professor Alfred Stock, Technische Hochschule, Karlsruhe, Germany. To this list may now be added: First term, 1932–33, Professor Cecil H. Desch, Sheffield, England; Second term, 1932–33, Professor Otto Hahn, Kaiser Wilhelm Institut für Chemie, Berlin-Dahlem, Germany; First term, 1933–34, Professor V. M. Goldschmidt, Göttingen, Germany; Second term, 1933–34, Professor Robert Robinson, Oxford, England.

THE American Astronomical Society has formed a

committee of twenty to proceed with the necessary organization for the meeting of the International Astronomical Union which is to be held in this country in 1932. An executive committee consisting of E. W. Brown, W. W. Campbell, R. S. Dugan, Frank Schlesinger, Harlow Shapley, Joel Stebbins and H. N. Russell has been selected, and several subcommittees appointed. The meeting will be held in Cambridge, Massachusetts, beginning as soon as practicable after the total eclipse of the sun on August 31.

THE Botanical Society of New Orleans was organized on October 9 with the following members as a nucleus: Professor William T. Penfound, Mrs. William T. Penfound, Mr. M. E. O'Neill, of the College of Arts and Sciences of Tulane University; Dr. Miriam L. Bomhard, Miss Anna Haas, of Newcomb College of Tulane University; Mr. E. L. Demmon, Dr. L. J. Pessin, Mr. Philip C. Wakely, Mr. W. G. Wahlenberg, Mr. P. V. Siggers, Mr. R. M. Lindgren, Mr. G. H. Lentz, Mr. J. D. Sinclair, Mr. Robert Winters, Mr. Henry Bull, Mr. H. G. Meginnis, of the Southern Forest Experiment Station; Mr. George Thomas, head of the New Orleans Parking Commission, and Mr. James McArthur, director of nature study in the Orleans Parish Public Schools. The organization proposes to interest itself chiefly in the taxonomy and ecology of the Gulf States, discussing particularly certain general phases of ecology from the standpoint of their local application. Professor Penfound is president and Dr. Bomhard is secretary-treasurer of the society.

Industrial and Engineering Chemistry writes: "An organization of Yale chemists and chemical engineers, to be known as the Yale Chemical Association, was formed on September 27, at New Haven. Some sixty men and women met at 'Bethwood,' the beautiful country home of Professor Treat B. Johnson, for a picnic luncheon and reunion. The guest of honor was Professor Emeritus W. G. Mixter, now in his eighty-fourth year, who is known and loved by several generations of Yale men. After the luncheon a brief meeting was held, at which Dean W. T. Read, of Rutgers, presided. Informal talks were made by Professor Johnson, Dean C. H. Warren, of the Sheffield Scientific School; A. J. Hill, chairman of the department of chemistry, and C. O. Johns. A nominating committee composed of H. W. Foote, C. R. Downs and E. M. Shelton presented a report which resulted in the election of the following officers: *President,* C. O. Johns; *vice-president,* E. B. Hurlburt; *secretary-treasurer,* J. J. Donleavy.

ACCORDING to the *Journal* of the American Medical Association graduate courses for surgeons and radiologists, held four times a year at the Johns Hopkins Hospital, were announced at the recent three-day graduate teaching course on "The Diagnosis and Treatment of Bone Tumors," held under the auspices of the Garvan Research Laboratories and the Copley Surgical Pathological Laboratory of the Johns Hopkins University, under the direction of Dr. Joseph Colt Bloodgood. The attendance comprised 363 physicians from 42 states. The plan is to supplement the new courses by correspondence and a system of diagnosis in which roentgen plates are sent in by nonresident radiologists. Another development announced in the war on cancer is the creation of a corporation to advance the science of radiology as it bears on the diagnosis and treatment of cancer. This corporation—the Radiological Research Institute—will finance research workers and fellowships in universities and is made possible by gifts from the Chemical Foundation and its president, Francis P. Garvan. The graduate course given at Johns Hopkins will be repeated before the meeting of the Radiological Society of North America in Los Angeles, December 1–5; the admission is free, but attendance is limited to 800.

DISCUSSION

THE FORMATION OF STRIAE IN A KUNDT'S TUBE

SOME experimental work has been carried on by the author from time to time on the formation of striae in a Kundt's tube. Since the summer of 1924 observations seemed to show a rotation of the dust particles on each side of the striae, and in July, 1929, the author succeeded in showing that such rotation does take place.

A glass tube about 150 cm long and about 2 cm inside diameter had some burned cork scrapings scattered along its inside. A sheet tin piston connected to one prong of an electrically driven tuning-fork was used to excite the air vibrations in the tube. The piston was inserted a short distance into the end of the tube and the other end of the tube was closed with a tight-fitting cork. When the fork was made to vibrate complete disks of cork dust were produced across the tube at the antinodes, and close observation showed that at each disk two distinct orbits of rotating particles were present, one on each side of a single striation, one clockwise, and on the opposite side a counterclockwise rotation. The rotations take place so that the particles leave the top of the stria-

tion and enter at the bottom of the same striation. Midway between two adjacent striae little striae lower than the others tend to form but are soon destroyed by the rotations mentioned above, the dust particles forming these lower striae being pulled away in opposite directions and forced into the two adjacent striae at the bottoms of the same. Thus the dust particles are pulled away from a line approximately midway between adjacent striae in opposite directions and forced into the major striae at their bottoms. When the agitation of the dust particles is violent the striae at the antinodes, especially those extending completely across the tube as disks, do not remain always in one position but very often merge into each other. When the agitation is less violent, as in the case where the striae do not extend completely across the diameter of the tube from top to bottom, there seem to be two orbits of rotation on each side of a striation, one above the other, rotating in opposite directions so that the direction of rotation is from near the middle of the striation, one orbit entering the top of the striation and the other orbit entering the bottom of the striation, somewhat as two meshed cogs, one directly above the other, would rotate.

While there seems to be experimental evidence in the scientific literature for the support of the explanation of the formation of striae in a Kundt's tube as given by Koenig,[1] the author is inclined to believe that the formation of these striae may be satisfactorily explained in a manner similar to the explanation for the formation of ripple-mark in sand as given by Darwin.[2]

In the summer of 1927 the author was able to maintain two paper segments (cut in a shape similar to a dust striation) upright in the tube. When pith dust also was present a violent somewhat elliptically shaped rotation, about an inch long along its major axis parallel to the axis of the tube, was produced. Also a single segment of paper similar to a dust striation has been maintained upright in the tube for a short time by means of the air vibrations.

In the summer of 1927 striae were obtained by the author by allowing puffs of air, produced by interrupting a continuous air stream from a small glass nozzle by a rotating siren disk, to enter a glass tube, one end of which was corked and in which pith dust was distributed along the bottom. These striae were formed when the air jet was interrupted too slowly to produce an audible tone.

The author is continuing his investigation of these striae photographically and is making an effort to determine the effects produced by forming them in various gases, in tubes of various diameters and lengths, and by sources of various frequencies.

Rolla V. Cook

Bethany College

[1] *Wied. Ann.*, 42: 353, 549, 1891.

[2] *Proc. Royal Soc.*, 36: 18, October 18, 1883.

A HYPOTHESIS ON THE CAUSATION OF CANCER[1]

According to genetics, all variations in species are due either to mutations of the chromosomes or to recombinations of chromosomes in which mutations have previously occurred. If this mutation occurs in a germ cell, it will result in a hereditary characteristic that will persist until the line is extinct or until a new mutation intervenes, but if this mutation occurs in any other cell of the body except a germ cell, it will persist only as long as the particular individual lives, and will become extinct with the death of this individual, unless the tissue of mutated type cells is transplanted to some other sustaining medium. (All cells other than germ cells are called somatic cells.) This latter type of mutation is called "somatic" mutation. Such mutation may be lethal or beneficial.

> *Cancer* is generally regarded as a localized lawless and unrestrained growth of epithelium, the cells (somatic) having become parasitic cells, and attacked the host. The only cure thus far discovered is an early destruction or removal of the abnormal parasitic cells.
>
> The causation of cancer apparently lies in the disturbed balance of the forces of stimulating and restraining growth in the affected cells, and is probably essentially a faulty cellular chemistry.[2]

Unequal distribution of chromosomes in somatic cells may result in abnormal tissue and also a change in the physicochemical components of one or more genes in those cells.

This hypothesis then considers cancer as due primarily to mutation in a somatic cell. That the mutation is *lethal* is borne out by its subsequent course. Its ultimate result is death of the individual, the mutation being of a somatic cell and not of a germ cell. Whether cancer is a heritable factor or not has never been clearly shown, but it is entirely possible that the *lack of resistance* to the same type of mutation reappearing in subsequent generations of the same line could be passed on as an inherited characteristic, as shown by the well-known frequency of cancer as a hereditary taint in such lines.

Therefore, the theory of a bacterial causation of

[1] The authors are deeply indebted to Dr. Herbert Fox, director of the Pepper Laboratory at the University of Pennsylvania, and to Professor W. R. Coe, professor of genetics and biology at Yale University, for their interest, advice and encouragement in the publication of this paper.

[2] Ferris, "Evolution of Earth and Man," p. 213.

cancer seems to be unnecessary, since it can be explained by a physicochemical fault, and if bacteria are found it is probably accidental.

Boveri[3] (1902) suggested that irregular somatic mitosis might well account for the peculiar behavior of these peculiar cells. He did not include other mutations, however.

Cancer cells show abnormal metaplasia. Instead of "flattening out" like normal epithelial cells they remain "swollen up." There is also a shift of the nucleus towards the center. They become parasitic and live at the expense of their sister cells.

Now something has happened in such cells to change their normal metaplasia. Bacteria have been held as the causative factor in this "change of stream," but this conviction is growing less and less. *True sarcoma,* however, has been found around tape-worms (Francis C. Wood) and other intestinal worms (Philadelphia Zoo Laboratory). Another factor often advanced has been a genetic factor where cancer is regarded as a true Mendelian recessive.

This hypothesis, it might be argued, would stand or fall on whether the Mendelian law is applicable to cancer families.

However, this hypothesis holds that it is a mutation of a *somatic* cell and not of a *germ* cell, that the mutation itself dies with the individual and is not transmitted directly, that the normal resistance to such imbalance may be weakened and this lowered resistance may be transmitted as a dominant or recessive characteristic or as a multiple factor. This factor would be subject to Mendelian laws.

Note: It is a well-known fact, genetically, that mutations experimentally can be speeded up tremendously by exposure to stimulating amounts of radiation and the X-ray effect, where greater doses are destructive. Perhaps the frequently observed "skin-cancers" in Roentgenologists are due to such mutations occurring from *stimulating* exposure to the X-ray effect (the release of the cathode ray).

Would it be possible that some such agency is active in the greatly increased prevalence of cancer? Of course, it is understood that other factors are concerned both in its relative and actual increase.

Evolutionary variations in species, due to mutations in the germ cells, have been very irregular in their intensity. There have been periods of extreme activity in this field, gradually shading down to a comparatively quiescent state. It is held by some that these periods of great evolutionary expansion have coincided with the great crustal revolutions of the earth, and that they may have been due to the influence of emanations from the radioactive ores that were released in these upheavals.

It is possible that in this intensive electrical age there may be radioactivity and rays that are beyond our present knowledge, which might be sufficient to stimulate mutations in the chromosomes of somatic cells. Again this same electrical influence might be of cosmic origin.

Babcock and Collins[4] performed an experiment with *Drosophila* comparing the rates of occurrence of sex-linked lethal mutations in a street-car tunnel in San Francisco and in their laboratory. A location was discovered in the tunnel where the natural ionization radiation was fully twice as great as the radiation in their laboratory in Berkeley. The difference in rate was 2.5 times the probable error for the flies which had been exposed in the tunnel. In other words, the rate of lethal sex-linked mutation was more than doubled when the flies were transferred to a more highly *ionized* location.

Hanson and Heys[5] performed independently similar experiments in a carnotite mine in Colorado where the air was strongly ionized. Their results check closely with those of Babcock and Collins.

While these two experiments fall short of being statistically significant, it is clearly shown that ionization plays an important part in the rate of mutation of the germ cells. It would not be too fanciful to assume that such ionization would also affect the rate of mutation of the somatic cells as well.

We admit that such a suggestion would be hard to determine by research, but study of the effects of X-ray radiations of a less intensity than necessary to inhibit all reproductive activity in cells might be of value.

Robert S. McCombs
Robert P. McCombs

THE MAGNETIC POLES OF THE EARTH AND THE BIRTH OF THE MOON

Dr. Oliver Justin Lee's article on "The Magnetic Poles of the Earth and the Birth of the Moon" in Science of July 25 interests me greatly.

A number of years ago I was impressed with the same fact, namely, that the magnetic poles are not on the axis of the earth, which would seem to be the logical place for them, nor are they even antipodal to each other. When I found that the shortest distance between them was across the center of the Pacific I immediately began to wonder if the removal

[3] Republished, "Origin of Malignant Tumors," Williams and Wilkins Company, Baltimore, 1929.

[4] E. B. Babcock and J. L. Collins, "Natural Ionizing Radiation and the Rate of Mutation," *Nature,* 124: 227–228, 1929.

[5] F. B. Hanson and Florence Heys, "A Possible Relation between Natural (Earth) Radiation and Gene Mutation," Science, 71: 43–44, 1930.

of the moon mass from the area which is now the Pacific was responsible for this peculiar fact.

In 1926 I had a number of mimeographed copies made of a short article on "The Origin of the Moon" which consisted of about 14 ordinary letter size sheets of typewritten material.

By 1927 I became impressed more with the earthly effects and had a twenty-six page booklet printed giving a large number of facts which seemed to me to support the theory that the removal of a large mass of crustal material, from what is now part of the Pacific Ocean, caused the shifting of the axis of rotation of the earth, caused the magnetic poles to become closer to each other on the Pacific side of the globe and created the major outlines of the continents. The title of this booklet is "The Formation of the Continents and Oceans as We Know Them."

In the September, 1928, issue of the *Pan-American Geologist* an article of mine on "Symmetric Disposition of Tertic Mountain Systems" was published. This calls attention to a very remarkable symmetry which is created when, on a globe, the magnetic poles, together with underlying continents, are placed back in their assumed original positions.

In the March, 1929, issue of the same journal another article of mine on "Continental Drifting in Northwestern Europe" was published. This article was not confined to a statement of the one bit of contributory evidence which the title indicates, but covers briefly some of the major features of my theory and the evidence supporting it.

In the May, 1930, issue of the same journal an article which I contributed on "Bilateral Symmetry of Earth's Largest Continental Block," with an illustration, described a symmetry of Europe, Asia and Africa around a great circle passing through the south magnetic pole, which I attribute to the removal of a large mass from part of the Pacific, which mass may now be our moon.

Before the Geological Section of the American Association for the Advancement of Science, at their Des Moines meeting last winter, I read a paper, with lantern illustrations, setting forth my theory and the facts on which it was built as well as a small part of the supporting evidence.

I have seen no other mention of this peculiar relationship that seems to exist between the magnetic elements of the earth and the major features of the earth.

Some of the conclusions which the evidence in the case has forced me to are almost revolutionary.

My theory, in a very peculiar manner, seems to fit in, to a certain degree, with Wegener's theory of continental drift of the Americas, so I submitted my theory to W. A. J. M. van Waterschoot van der Gracht, who recently conducted a symposium on the theory of continental drift. Of my theory and the facts which I advance in support of it he recently wrote me as follows:

> These curious magnetic facts must have *some* explanation, and they may be very important for further speculation as to the internal constitution of the earth, and also for the changes in its facial expression. . . . I think that your work brings some very interesting new facts and arguments into the discussion of this most involved problem. . . . Your discussion of the magnetic situation is very interesting and certainly deserves further work and thought.

D. W. Longfellow

Elk River, Minnesota

THE CONCEPTION OF BALANCE WITH RESPECT TO THE ABSORPTION OF NITROGEN, PHOSPHORUS AND POTASSIUM BY PLANTS AND THE INFLUENCE OF THE LEVEL OF NUTRITION

In a recent paper, the writer[1] called attention to the remarkable and consistent results obtained over a 10-year period by Lagatu and Maume[2] from a series of field experiments conducted with the grape (*Vitis vinifera*). These authorities concluded that the depression in yields produced by the application of an "incomplete" fertilizer, *i.e.*, one containing only two of the principal fertilizer constituents, nitrogen, phosphorus, potassium, is not due to a *depression* of the absorption of the remaining elements, but, on the contrary, to a nutritional lack of balance owing to an *increased* absorption of these elements.

Field experiments have also been reported[3] in which it was noted that the omission of potassium from a fertilizer applied to a soil deficient in this element resulted in an *increased* absorption by the plants of the nitrogen and phosphorus present in the "incomplete" fertilizer. But in these experiments of Wallace it is to be noted that the omission of nitrogen from the fertilizer resulted in a *decreased* absorption of phosphorus and potassium, and the omission of phosphorus in a *decreased* absorption of nitrogen and potassium.

In the course of experiments[4] with *Pyrus malus* L. grown under controlled conditions, the writer has had a unique opportunity of examining the principles

[1] Walter Thomas, Science, 70: 382–384, 1929.

[2] H. Lagatu, *Compt. Rend.*, 172: 129, 1921; H. Lagatu and L. Maume, *Compt. Rend.*, 179: 782, 1924; *ibid.*, 179: 932, 1924; *ibid.*, 180: 1179, 1925; "Communication au Congrès des engrais azotés de synthèse à Montpellier," Juin 1, 1927, pp. 1–15.

[3] T. Wallace, *Jour. Pomol. and Hort. Sci.*, 7: 130–145, 1928.

[4] Walter Thomas and R. D. Anthony, *Proc. Am. Soc. Hort. Sci.*, 81–87, 1926; Walter Thomas, *Plant Physiology*, 2: 109–137, 1927.

enunciated by Lagatu and Maume. It has been found in our experiments that the course of absorption of nitrogen, phosphorus and potassium from fertilizer mixtures containing only two of them is in accordance with the deductions made by Liebig.[1] Thus, a comparison of the absorption graphs of trees receiving additions of two only of the elements, nitrogen, phosphorus, potassium, with the absorption graphs of trees which received additions of all these elements indicates a depression of the absorption of the elements from the "incomplete" or unbalanced fertilizer.

Since, therefore, generalization of Lagatu and Maume's principles is not permissible, it is pertinent to seek an explanation of the causes operative. The discrepancy between the results of the experiments under discussion may not be attributed to differences in the ratios, amounts or composition of the fertilizers applied, for these are very similar. The conception of physiological balance resulting from Loeb's[5] pioneer experiments and its further expansion by McCool,[6] Osterhout[7] and others have stimulated a vast amount of investigation by plant and animal physiologists and, although quantitative experiments[8] with plants have been made to ascertain the factors influencing the selective absorption (diffusion) into the cell of one salt (or ion) by another present in the nutrient solution, the discovery of a general law applicable under all conditions has not been forthcoming. It is, however, apparent from such experiments that there exists for each species a physiologically balanced nutrient solution—which may in actual field practice be determined by the method of Mitscherlich[9]—from which normal permeability occurs; and that a departure from this balance will produce a disturbance in the rate of absorption relations of the various ions that may have a profound effect on metabolism.[7] Normal permeability has been explained[10] on the basis of antagonistic salt action; but the extent to which salt (or ion) antagonism is responsible for the maintenance of normal permeability of plants grown under field conditions is problematical. In the field experiments here cited the results do not appear to be applicable on the basis of simple antagonism—at least in the sense defined by Loeb[10] and as discussed more recently by Loehwing[11]—for plants grown on these soils containing normal concentrations of calcium ions absorbed more (not less) potassium from a fertilizer containing only nitrogen and phosphorus. There is evidence,[7] moreover, to show that antagonism becomes weaker and weaker as the concentration decreases. Thus, Osterhout found that although 0.05 M $NaCl$ + 0.06 M $CaCl_2$ exerted a marked toxic effect on root growth, 0.001 M + 0.0012 M solutions, respectively, of this mixture had no antagonistic effect. We should expect, therefore, little or no antagonistic effect in solutions of such low concentration as that of the soil solution. For example, the concentration of salts in the soil in the present experiments varied from 350 to 640 p.p.m. according to the season. In all nutrient culture experiments with seedling plants in which the phenomenon of antagonism has been observed, the concentration of salts present is from five to twenty times that of the salts in the soil solution from normal soils.

However, although ion antagonism may be of negligible consequence in solutions as dilute as the soil solution, experimental evidence exists to show that the concentration of nutrients (level of nutrition,[9, 12] *i.e.*, rate of supply of nutrients[13] or supplying power[14]) of the soil solution may be the factor of greatest influence in determining the course of absorption. Thus, from Remy's[15] numerous field experiments it is apparent that the addition of any two of the elements, nitrogen, phosphorus, potassium, to soils relatively deficient in these elements, such as the Hagerstown clay loam soil used in the experiments of the writer, results in a *decrease* in the absorption of the remaining element in accordance with the deductions of Liebig.[1] This decreased absorption does not occur on soils—such as that used by Lagatu and Maume[2]—well supplied with these elements, but always an increased absorption.[15,16] In this connection it is of interest to note that Waynick[17] observed

[5] Jacques Loeb, "Opperheimer's Handbuch der Biochemie des Menschen und der Tiere," Zweiter Bd., Teil I, Gustav Fischer, Jena, 1909.

[6] M. M. McCool, Cornell Univ. Agr. Exp. Sta. Memoir No. 2, 119–216, 1913.

[7] W. J. V. Osterhout, "Injury, Recovery and Death in Relation to Conductivity and Permeability," J. B. Lippincott Company, Philadelphia, 1922.

[8] D. D. Waynick, *Univ. Calif. Pub. Agr. Sci.*, 3: 135–242, 1918; D. R. Hoagland and J. C. Martin, Univ. Calif. Pub. Agr. Exp. Sta., Tech. Paper No. 8: 1–26, 1923; H. S. Reed and A. R. C. Haas, *Jour. Agr. Res.*, 24: 801–814, 1923; Univ. Calif. Pub. Agr. Exp. Sta., Tech. Paper No. 11: 1–23, 1923; Univ. Calif. Pub. Agr. Exp. Sta., Tech. Paper No. 17: 1–75, 1924; D. R. Hoagland and A. R. Davis, *New Phytologist*, 24: 99–111, 1925; E. Pantanelli, *Protoplasma*, 7: 129–137, 1929.

[9] A. Mitscherlich, "Die Bestimmung des Düngerbedürfnisses des Bodens," Paul Parey, Berlin, 1925.

[10] Jacques Loeb, "Dynamics of Living Matter," Columbia University Press, New York, 1906; *Biochem. Ztschr.*, 32: 308–322, 1911; SCIENCE, 36: 637–639, 1912.

[11] Walter F. Loehwing, *Plant Physiology*, 3: 261–275, 1928.

[12] H. P. Cooper, *Plant Physiology*, 5: 193–214, 1930.

[13] D. R. Hoagland, *Jour. Agr. Res.*, 18: 73–117, 1919.

[14] Burton E. Livingston, Proc. Intern. Congress Plant Sciences, Ithaca (1926), Vol. 2, pp. 1107–1121, the Collegiate Press, Menasha, Wisconsin, 1929.

[15] Theodor Remy, "Untersuchungen über das Kalidüngerbedürfnis der Gerste," Paul Parey, Berlin, 1898.

[16] F. Sekera, *Ztschr. für Pflanzenernähr. u. Düngung*, 7–B: 533–539, 1928.

[17] D. D. Waynick, *Univ. Calif. Pub. Agr. Sci.*, 3: 135–242, 1918.

in culture solutions greater antagonism between 0.04 M $MgSO_4$ + 0.18 M KCl than from mixtures containing higher concentrations of $MgSO_4$.

The factors involved in the absorption of salts (or ions) by plants have been discussed by the writer,[18] and a recent paper by Cooper[12] presents some stimulating new ideas on the subject. The causal relations are known to be extremely complex. Nevertheless, although the factors producing differential absorption and influencing utilization of elements within the plant at the different planes of nutrition may not at the present stage of our knowledge be identified, the interpretation advanced to account for the discrepancy between Lagatu and Maume's results and those of the writer is the only one that, at the present stage, accounts for the observed facts. Details of the experiments will be published elsewhere.

Walter Thomas

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THE ORGANIC WORLD AND THE CAUSAL PRINCIPLE: A CRITICISM[1]

With some reservations, the theory of evolution as propounded by Darwin three quarters of a century ago is accepted by most psychologists of the present day. We use accepted advisedly. To the psychologist the view-point and all the accumulated data are gifts. As a group we have done little to advance this illuminating principle nor have we been greatly interested in understanding the far-reaching significance of its many aspects. We have been content to believe but not to strengthen the basis for belief. Ours has largely been a lip service to Darwin and this in spite of treatises of imposing titles purporting to deal with one or another aspect of the evolution of mental life. Having accepted evolution as fundamental to our science we have not oriented our concepts with regard to it. Not uncommonly we observe that an author may profess to a purely mechanistic viewpoint on one page and on the next offer "inhibition" as the solution of some felt difficulty. The "inhibition" is not evaluated in the light of the "mechanism." Inhibition, in any form in which we have seen it stated, is in opposition to at least one of those general principles which we have come to call the laws of nature.

Perhaps it is the feeling of a lack of critical evaluation of our concepts which leads our students to question whether or not psychology is a science. Possibly it is the same vague feeling on our part which motivates us either to spend valuable time and energy in demonstrating in our text-books and classrooms that psychology is a science, or to assume the "I don't care" attitude. That this lack has been felt is indicated in a new note that has recently been struck by Warren in his vice-presidential address. Warren clearly sees that a vast amount of revision must be made in our mode of thinking if we are to make full use of the principle of evolution. Primarily his article is an attempt to demonstrate that principles of causation characteristic of organisms may be assumed without damage to the mechanistic conception of life. Two such principles, he concludes, are natural selection and anticipation.

It is in hope of furthering rather than opposing the general point of view that we raise the question: Are these two principles characteristic of biological systems and are they causally related to evolution? There seem some grounds for believing that they are not, but before entering a discussion of causation it will be well to specify what we conceive the term to mean. A cause, we understand, is any event which directly or indirectly delivers energy to another event. A clear distinction must be made between causal factors and limiting factors. Silver nitrate in a transparent container undergoes certain changes when exposed to the sunlight. Causal efficacy will hardly be attributed to the container in so simple a case. Its only influence is to limit the amount of energy delivered to the solution by the sun. It is further evident that so long as we are dealing with one time frame the delivery of energy will take place only in the forward direction, and that the assumption of retroactive causation will make a hodge-podge out of all science. Cause must precede effect.

Of the supplementary causes which Warren conceives to be characteristic of organisms he says, "The first of these supplementary principles is that of natural selection. . . . It does not occur—it has no meaning whatever—except in connection with those peculiar groupings of molecules which we call organisms. . . . It is perhaps unnecessary to-day to emphasize the importance of selective adaptation[2] in promoting organic evolution. Through its means the organization of matter takes on an entirely new trend."

In communication with Warren he informs us that he does not conceive of natural selection as a cause but rather that it is based upon causation, and nowhere in his speech will the term "cause" be found when he refers to these supplementary principles.

[18] Walter Thomas, *Soil Sci.*, 27: 249–270, 1929; *Plant Physiology*, Vol. 5, No. 4, 1930 (forthcoming).

[1] A paper appearing in Science, February 21, 1930, bearing the same title, was the publication of Howard C. Warren's address as retiring vice-president and chairman of Section I—Psychology, American Association for the Advancement of Science, Des Moines, December, 1929.

[2] Natural selection and selective adaptation are used synonymously by Warren.

However, it must be pointed out that the above extracts indicate that causal efficacy is being attributed to natural selection. Only a cause can promote and only a cause can organize matter.

Natural selection is a term used to indicate that the survival of a system is limited by environmental conditions. Those organizations of matter which do not find themselves within the limitations imposed by the environment do not survive. Unfortunately we have come to speak of natural selection as acting in this or that way. It does not act in any way. It is not a force. It does not deliver energy to organisms. It limits in one way or another the delivery of energy to organisms and nothing more. Natural selection, then, since it is purely an abstraction and is quite devoid of energy, may not in any way be conceived to be causally related to evolution. It can not promote evolution and it can not organize matter. It is to be pointed out that Darwin did not make this error. He saw only too clearly that natural selection could but limit the forms that would continue to evolve.

It may be remarked in passing that it is even possible that we have overemphasized the importance of natural selection in limiting the survival of forms. We observe that a large number of widely divergent forms survive within the limitations of any given environment. If, as Claude Bernard and Beaunis have held, evolution is a characteristic of organisms, it follows that offspring will arise which are slightly different from, and perhaps slightly more complex than, the parent. Evolution, although characteristic of organisms, will not cause these changes. Rather evolution is the final result obtained from the summation or integration of the series of changes. The range of these differences will be wide, but since the organism may be considered as a Gibbs system the number of possible changes, or the degrees of freedom, will be expressed by the phase rule. Further, death, the return to equilibrium, also being characteristic of multicellular organisms, it follows that new forms will appear and the old forms disappear in an environment equally beneficent to all. Without doubt there have been cataclysmic changes at certain periods during the course of organic evolution, but it must be recognized that evolution goes on in the absence of such. Natural selection acts in no way to produce new forms. It can only limit the survival of whatever new forms may appear. The old question of the origin of variations remains unanswered by natural selection now just as in Darwin's time.

That natural selection "has no meaning whatever" except in connection with organisms is not apparent to us. Karl Pearson in his "Grammar of Science" has a chapter on natural selection in the inorganic world. This question seems to us to be merely one aspect of the phase rule. Water survives in its solid form at the earth's poles. Fresh-water lakes survive only in regions of moderate temperature. Certain rocks are selected for sands and certain sands selected for rocks. Natural selection is as old as evolution and evolution as old as the universe. Biological organisms are not new systems as Warren has stated. Organic and inorganic are both Gibbs systems. The difference between the two, as Baldwin has pointed out, is that the series of changes in living organisms is always irreversible.

Except for one, Warren foresees the arguments against his second supplementary principle, as is evident from the following extract:

> Recently a tornado was reported in the Caribbean Sea moving in the direction of Florida. Preparations were made at once to prevent the loss of life and minimize the damage to property. Ships altered their course. Buildings were shored up. Dwellers in the everglades were transferred to more elevated ground. All these activities were in response to what stimuli? In a measure they were reactions to present verbal stimuli—telegrams, storm signals, newspaper bulletins, radio messages, individual warnings by word of mouth. I have no doubt but that if a superscientist were to trace the cause-and-effect relations of this series of responses in the case of any person involved, he would find that the fundamental causal principle[3] accounted fully for the person's activity. But this causal explanation does not exhaust the meaning of the behavior. The activity of some thousands of individuals in this instance has reference to a certain future situation as well as to the present. As a matter of fact, in cases like this the immediate antecedents (the verbal stimuli) may be regarded as merely incidental—the responses were primarily to stimuli which were yet to come.

In psychology we are accustomed to say that a response is determined by the condition of an organism and the stimuli acting on it. Warren's example provides no exception to this general statement, we believe. Energy is stored up by metabolism and other processes in the anterior end of the central nervous axis of the Florida inhabitants in the form of learning. This in part determines the condition of the organism, the remainder being determined by the present stimuli. That the present response is neither "primarily" nor even remotely caused by "stimuli which were yet to come" is apparent when we recall that frequently under the above conditions, after all the responses have been made, the event "tornado in Florida" does not materialize. We should then have a response without a stimulus. Responses do not transcend their stimuli. There can be no "referring to" some future stimuli. The Florida

[3] The law of conservation of energy.

tornado is in no way a cause of the Florida activity. Energy is not retroactive. Event A, happening to-day, can not be influenced by event B, happening to-morrow. A and B may influence C, and in Warren's example the shoring up of the houses is an important cause of a later event which is "intact houses" after the tornado. Warren, we believe, has interpreted the effects of past experience, learning, as being the effect of some event which may or may not occur at some future time.

Warren has not demonstrated any new causes or principles in evolution. His examples are not energy manifestations, though he appears to use them as such. Any search for causal factors must be directed towards the possible sources from which organisms may derive energy. As has been pointed out by one of us,[4] there seems only one source available for all organisms, and this, the energy of the sunlight, is the motive force behind the appearance and evolution of organisms on the face of the earth. The series of living organisms is a series upon which work has been done, and in the source of this work we are to seek for the cause of evolution.

M. N. CHAPPELL
F. H. PIKE
COLUMBIA UNIVERSITY

SPECIAL CORRESPONDENCE

THE PALEOBOTANICAL EXCURSION OF THE FIFTH INTERNATIONAL BOTANICAL CONGRESS

IMMEDIATELY following the close of the Fifth International Botanical Congress at Cambridge, England, on August 23, 1930, a tour was undertaken for the purpose of visiting some of the fossil plant localities in England and Wales. The tour was organized by Dr. H. H. Thomas, of Cambridge, and was conducted by Mr. W. N. Edwards, of the British Museum.

The party left Cambridge by motor bus on the afternoon of August 23 for Cayton Bay, near Scarborough, on the Yorkshire coast. Here, under the direction of Dr. Thomas, the Upper Jurassic beds containing the oldest known angiosperms, the Caytoniales, were visited and an opportunity was given to collect material.

The party then proceeded to Leeds where, under the direction of Dr. Hudson, several localities were visited for upper Carboniferous plants. Leaving Leeds the route followed was across the Pennine Moors to Manchester, where two days were spent. Besides visiting the coal mines in the vicinity of Manchester the party was entertained at tea by the botany department of the university and an opportunity was given to examine the magnificent fossil collection in the geological museum.

The party was then accompanied by Dr. John Walton, of Manchester, to north Wales. The first objective was the Teilia quarry near the village of Gwaenysgor for lower Carboniferous plants. Afterwards the Archeosigillaria beds at Denbigh were visited.

The south Wales coal field was the next objective. The route followed was along the scenic highway to Llangollen, then through Shrewsbury and Brecon to Swansea, which is one of the two centers of the coal industry in south Wales. On arriving at Swansea the party was entertained at tea by the mayor and at luncheon the next day by Captain H. Rees, of the Cefn Coed Colliery at Crynant. During the two days following the arrival at Swansea the party was conducted by Dr. A. E. Trueman, of the University College at Swansea, and Miss Emily Dix, of London. Numerous coal mines in the middle and transition Coal Measures were visited and rather extensive collections were made. On the evening of the last day the party was entertained at dinner by the Swansea District of the Monmouthshire and South Wales Coal Owners' Association and the South Wales Institute of Engineers.

The trip was concluded by visiting the mines in the vicinity of Bristol, Gloucester and Bath for upper Carboniferous plants under the direction of Dr. Crookall, of the British Geological Survey. The party then proceeded to London.

The participants of the tour were the following: Dr. T. G. Halle and Baron von Post (Stockholm); Dr. O. A. Høeg (Trondhjem); Professor A. Renier and Mme. Ledoux (Brussels); Professor and Mme. Jongmans (Heerlen); Professor W. Gothan (Berlin); Professor and Frau Hirmer (München); Dr. Sze (China); Professor Rudolph (Prague); Mr. W. N. Edwards and Miss E. Dix (London); Dr. G. R. Wieland (Yale), and Dr. C. A. Arnold (Michigan). Professor B. Sahni (Lucknow) and Dr. J. Pia (Vienna) accompanied the party for the first couple of days.

CHESTER A. ARNOLD
UNIVERSITY OF MICHIGAN

SUMMER INSTITUTE FOR BIOLOGICAL RESEARCH AT AMOY, CHINA

THE first attempt at a marine biological station in China was begun this summer at Amoy in southeast-

[4] F. H. Pike, *Ecology*, 10: 167–176, 1929.

ern China. For years the biologists in China have been exploring different parts of the coast to decide where such a station could best be placed. The north China coast is singularly poor faunistically. Here at Amoy the marine fauna is rich and various, a transition region between the Palearctic and oriental forms. There are sandy beaches, mud flats and rocky islands, and near here is the famous amphioxus fishing ground where amphioxus is caught by the ton and sold for food at four cents gold a pound.

Amoy has a university situated directly on the coast, with a modern well-equipped biology laboratory building. Dr. T. Y. Chen (one of Professor T. H. Morgan's students), who is now professor of zoology at Amoy University, with the cooperation of President Lim Boon-Keng, a university president with a real interest in scientific development, and the financial assistance of the China Foundation for the Promotion of Education and Culture, of which Mr. H. C. Zen is chairman, has opened the Amoy Biological Laboratory for summer research work and invited a group of about twenty-five biologists as guests the past summer, to initiate a China Marine Laboratory. The group has the usual international character of every science gathering in China—Chinese, American, British and German. We have been most hospitably entertained by the university, living in the buildings and eating at a common mess. Fifteen institutions are represented: Northeastern University in Mukden, Yenching University and Peking Union Medical College in Peking, Ginling College in Nanking, Soochow University, Shanghai College and Chi-Nan University in Shanghai, Hangchow College, Nanchang Academy, Fukien Christian University in Foochow, Amoy University and Anglo-Chinese College in Amoy, Lingnan University and Sun Yat Sen University in Canton, and the University of Washington in Seattle.

The research has been of several types, faunistic, experimental and cytological, concentrating on living amphioxus, but including also Teredo, Squilla, fishes, amphibia, insects, protozoa. The actual results of this first summer may not be great, but it is a beginning.

Dr. Chen is starting a supply service to furnish Chinese marine forms to the laboratories of China. This ought to be a good supplement to the world supply of amphioxus.

This whole venture is an instance of President Lim's scientific enthusiasm and one more of the far-sighted ways in which the China Foundation is encouraging science development in China. Biologists on sabbatical trips around the world ought to stop at Amoy. It lies half way between Shanghai and Hong Kong and can be reached by coast steamer from either port.

A. M. BORING

YENCHING UNIVERSITY

QUOTATIONS

WARD'S NATURAL SCIENCE ESTABLISHMENT

THE cradle of taxidermy in this country was destroyed when Ward's Natural Science Establishment in Rochester, with its irreplaceable collections, went up in smoke. Many a man who later became famous as a naturalist started his career as an apprentice at Ward's, stuffing birds and fishes and four-legged beasts. One of them, the late Carl Akeley, walked through the jaws of the sperm whale at the entrance when a youth of 19 and gleefully accepted a job at \$3.50 a week, although the cheapest board and lodging he could find in Rochester cost him half a dollar more. His book, "In Brightest Africa," contains a list of some of the young enthusiasts he knew there or who preceded him—E. N. Gueret, George K. Cherrie, J. William Critchley, H. C. Denslow, William T. Hornaday, Henry L. Ward, Frederick S. Webster, Frederic A. Lucas, William Morton Wheeler. The roster reads like a page from a naturalist's Who's Who.

Taxidermy in those days was rather a trade than an art. The skin of an animal was first treated with salt, alum and arsenical soap. After the bones had been wired and put in there was nothing more to do but hang the body upside down and stuff it with straw until it would hold no more. No attempt was made to put the animal in a natural attitude. The reason for this crude work, Akeley explains, was not that Professor Ward and his assistants knew no better, but that nobody would pay for better work. The museums for which the establishment prepared specimens cared more for purely scientific data than for exhibitions that would interest the public. They had no taxidermists of their own and generally preferred collections of skins and skeletons to mounted groups. Ward's men would tackle anything from a humming bird to an elephant. Their largest job was the stuffing of Barnum's mighty Jumbo. The mounted skin of this most famous of pachyderms is at Tufts College; its skeleton is in the American Museum of Natural History in this city.

For the present artistic perfection and scientific accuracy of taxidermy Akeley deserves a great share of the credit. He invented many new methods. He was one of the first to realize the importance of a

knowledge of animal anatomy, and his natural bent for sculpture gave an artistic quality to all his work. The modern taxidermist, instead of stuffing the skin of an animal with straw and rags, mounts it on a waterproof manikin made whenever possible from a plaster cast of the body. The animal is seldom placed on display without a stage setting suggesting its proper habitat. It is a far cry from the Ward's Natural Science Establishment of Akeley's youth to the great institution at Central Park West and Seventy-seventh Street, but in numerous respects Ward's led the way.—*The New York Sun.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR WORKING ON THE TERMINAL NERVE-MUSCLE UNIT

THE method here described[1] makes possible a direct experimental study of the terminal motor axone with its attached muscle fiber. Thus, in one field and focal plane with active circulation, an ultimate member of the motor-unit can be identified, operated upon and selectively stimulated under the compound microscope.

A technique employed by us for recording *in situ* by reflected light the mechanical response of muscle fibers in the retrolingual membrane (*membrana basihyoidea*) of the frog has recently been reported.[2] On noting in this structure the frequent presence of terminal nerve filaments (from *n. hypoglossus*) we have since met the requirement of transmitted light by a procedure similar to that devised by Richard Thoma for the observation of leucocyte migration and published at Heidelberg[3] in 1873. Both nerves and muscle fibers are mentioned by Thoma, who points out the many conditions fulfilled by the preparation in the study of living tissue elements.

The intrinsic lingual muscle fibers (*stratum arcuatum* Gaupp) which from either side enter this delicate membrane bounding dorsally the extended tongue form a transversely, somewhat sparsely disposed branching and anastomosing system. The fibers, though suggesting thus an interconducting syncytium, are nevertheless partitioned into discrete members each of which is of the striated-voluntary type. Since Thoma's observations these fibers have from time to time been an object of interest to workers on muscle structure and function, notably Ranvier[4] and Kahn,[5] and have come recently under special notice in a fruitful examination of the credentials of the all-or-none law.[6]

[1] *Cf.* abstract, F. H. Pratt and M. A. Reid, *Proc.* Am. Physiol. Soc. (Chicago meeting, March 28–29, 1930); *Am. J. Physiol.*, 93: 681, 1930.

[2] F. H. Pratt, *Am. J. Physiol.*, 93: 9, 1930.

[3] Verlagsbuchhandl. v. Fr. Bassermann. Buchdruck., G. Otto, Darmstadt.

[4] L. Ranvier, *Compt. Rend. Acad. Sci.*, 110: 504, 613, 1890.

[5] R. H. Kahn, *Zentralbl. f. Physiol.*, 17: 745, 1903–04.

[6] E. Fischl and R. H. Kahn, *Pfl. Arch.*, 219: 33, 1928; F. H. Pratt and M. A. Reid, *Proc.* XIII Int. Physiol. Cong., *Am. J. Physiol.*, 90: 480, 1929; S. Gelfan, *Am. J. Physiol.*, 93: 1, 650, 1930; H. Hintner, *Pfl. Arch.*, 224: 608, 1930; F. H. Pratt, *loc. cit.*

The *motor-unit,* a term introduced by Sherrington[7] to denote the nerve fiber with the muscle fibers governed by it, is known to be adapted in its pattern to the directional demands on the muscle in developing tension. Thus in the sartorius[8] the motor-unit is linear in disposition, involving formation in files of the "squad"[9] of muscle fibers under command of the neurone. This close formation of a group intimately bound into the muscular matrix offers little feasibility of detailed inspection *in vivo.* With the retrolingual membrane, however, the tension requirement is highly diffuse;[10] it is correlated with a dispersion or deployment of the muscle-squad in essentially one plane, the fibers being none the less completely integrated through the nerve strands passing along and across the intervals formed by the divergence and loose intertexture of the musculature (Fig. 2) as it invades the membrane from the arcuate layer. It should therefore be possible, with proper illumination and control, to take practical advantage of this natural isolation of what may be termed respectively a motor sub-unit (branch system subordinate to the motor-unit) and the motor-terminal (ultimate sub-unit—the innervated muscle fiber).

In Thoma's method[11] the everted tongue is stretched over a glass plate after an opening for transmission of light has been made in what is now the floor of the superficial lymph sac (*sinus basihyoideus*). This admits of continued circulation, the preparation being kept moist by irrigation. With the present modification, however, it is unnecessary to stretch the tissues since a glass disc or cylinder supports the membrane and fills the opening beneath it, with the further advantage that manipulation is afforded without deranging the focal position; as, for example, in the mechanical blocking of impulses in single nerve fibers. Even with extensive pithing the capillary circulation in the preparation may be highly active and persistent, all tissues under observation being immersed.

[7] C. S. Sherrington, *Proc. Roy. Soc.* B, 105: 332, 1929; J. C. Eccles and C. S. Sherrington, *ibid.*, 106: 326, 1930.

[8] S. Cooper, *J. Physiol.*, 67: 1, 1929.

[9] E. L. Porter, *Am. J. Physiol.*, 91: 345, 1929.

[10] R. H. Kahn, *loc. cit.*

[11] R. Thoma (illustrated description), Abderhalden's Handb., V, 4, 1924, p. 1928.

A disc made from a segment of glass rod (about 5 x 4 mm for *R. pipiens*) is cemented with balsam to a glass plate (*a*, Fig. 1). The tongue of the pithed or narcotized frog is everted and an incision made through its mid-region as far as the membrane, avoiding undue hemorrhage from the rich bilateral vascular supply. The preparation is now adjusted (prone position) so that the tongue, *b*, rests on the plate above mentioned, with the disc penetrating the open-

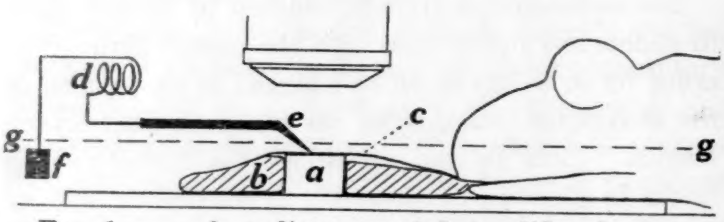

FIG. 1. *a*, glass disc cemented to slide; *b*, tongue (mid-sagittal section); *c*, retrolingual membrane; *d*, secondary coil; *e*, active electrode; *f*, indifferent electrode; *g–g*, submersion level.

ing so as to support the endothelial surface of the membrane. The entire preparation is laid in a Petri dish and covered with Ringer's fluid to above the level of the membrane, which may now be transilluminated under the microscope and at the same time manipulated from above. Although low powers suffice for most experiments a high-power objective immersed in the solution gives excellent definition.

For stimulation the unipolar method is conveniently used. An indifferent terminal rests in the bath covering the preparation. The active electrode may take various forms; we have worked largely with quartz-covered platinum electrodes (diameters between 2 and 10 μ) of the type described by Taylor,[12] carried in a manipulator mounted integral with the carriage of the preparation. A micro-needle in a second manipulator is readily added to the apparatus. By means of this system single or faradic induction shocks are delivered to any point in the field, the intensity being graduated over a wide range with great delicacy by coarse and fine sliding rheostats—the former in series with the primary circuit, the latter on a shunt across the primary terminals in series with a further set of resistances variable up to 11000 ohms.

On exciting a single motor nerve fiber (see Fig. 2) it is very readily evident that the responding muscle fibers are those limited to innervation by the ramifying nerve filaments of the unit, that the nerve threshold is distinctly lower than the muscle threshold and that one has to deal with a system having a capacity of performance not only independent of changes in the intensity of stimulation but, so long as other factors are in abeyance, of unvarying char-

[12] C. V. Taylor, *Proc. Soc. Exp. Biol. & Med.*, 23: 147, 1925.

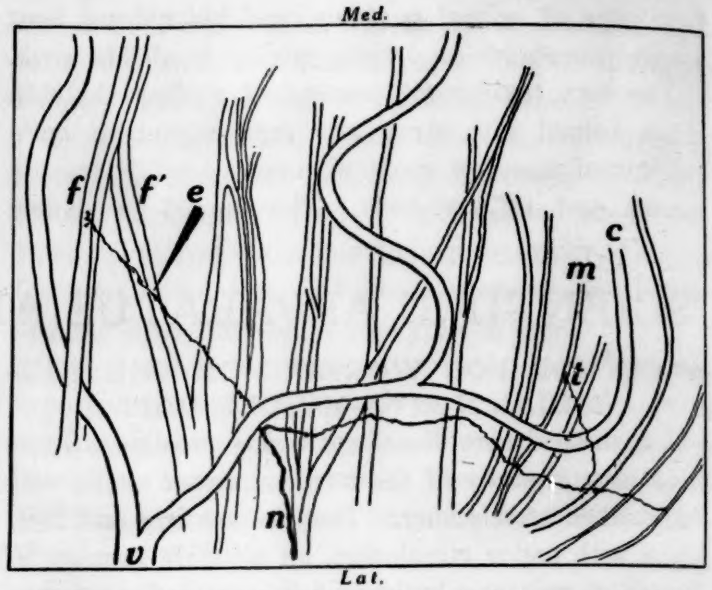

FIG. 2. Outline based on a typical nerve-containing field, retrolingual membrane, $\times 50$: *v*, vein; *c*, capillary; *n*, myelinate nerve fiber; *t*, one of its terminal filaments; *m*, one of a sub-unit group of muscle fibers that respond with the motor-unit to stimulation by *e*, the active electrode (axone reflex). If the nerve be cut or compressed between the contact of *e* and the structures central to it, and again stimulated, only the muscle fibers (*f*, *f'*) distal to the block respond. If the electrode be moved slightly from the nerve the fiber *f'* alone responds, but at a higher threshold. Being thus directly excited it may, especially if touched, show partial, gradable contractions as described by Gelfan and by Hintner (*loc. cit.*) and, for the sartorius, by Brown and Sichel.[15] The outline is semi-diagrammatic and slightly composite. No morphologic interpretation is here to be placed upon detail indicating contacts between nerve and muscle.

acter. Functional isolation of one motor-terminal is to be obtained by cutting or otherwise blocking the filaments passing to other muscle fibers of the unit, or by actual destruction of such fibers. The area of innervation (locus of "end-organ") appears with sufficient definition to enable the observer to manipulate the electrode with a considerable degree of selectivity. The persistence of thresholds, which are obtainable with great exactitude, appears to be correlated with the circulatory conditions. Frequently a muscle fiber with the innervating collateral is in immediate relation to an actively conducting capillary the walls of which are defined in optical section with extreme clearness. After circulatory failure or mechanical injury,[13] or in the course of fatigue or curarization,[14] the relative excitatory conditions of axone and muscle fiber are again readily investigated; the effect of nerve

[13] Our results are here in agreement with Hintner's (*loc. cit.*) observations on stimulation of the hypoglossal nerve in the excised tongue.

[14] F. H. Pratt, *Proc.* Am. Physiol. Soc. (Chicago meeting, March, 27–29, 1930); *Am. J. Physiol.*, 93: 608, 1930.

[15] D. E. S. Brown and F. J. M. Sichel, SCIENCE, 72: 17, July 4, 1930.

fiber on muscle fiber has so far proved consistently maximal.

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A NEW TECHNIQUE IN TREE MEDICATION FOR THE CONTROL OF BARK BEETLES[1]

The possibility of injecting chemicals into the sap stream of living trees in order to inhibit the action of parasitic organisms or correct some pathological condition has appealed to botanists and entomologists for a number of years. Variations of this method of control have likewise been utilized by so-called "tree doctors" to reap no inconsiderable return from unsuspecting owners of valuable shade trees, usually without accomplishing the desired results. A number of valuable contributions in this field and on related subjects have been made as a result of careful experimental work.[2] That it is possible to introduce fluids into the sap stream has been conclusively demonstrated, but in most cases the results have been of limited practical value. This is because usually these substances are not well distributed through all portions of the tree. Good distribution, even to the leaves, has been reported in those portions of the tree in direct communication with the point of injection, but the lateral dissemination has usually been slight.

In the summer of 1925, following the publication of results obtained by Lipman and Gordon,[3] the writers and Mr. J. A. Beal at Asheville, North Carolina, attempted to use the method therein described to destroy the developing broods of the southern pine beetle (*Dendroctonus frontalis* Zimm.) in shortleaf pine. It might be explained here, in reference to this insect, that these beetles attack the trees simultaneously in great numbers, bore through the bark and in about ten to fifteen days completely girdle the inner phloem and at the same time introduce blue-stain.[4] The trees after attack are necessarily doomed and, for the objective at hand, there was no effort made to save them. It was desired merely to kill the developing broods under the bark and thus prevent their escape and attack of other living trees. The control practices now in use for the bark beetles of the genus Dendroctonus consist in felling the tree and either peeling or burning the bark of the entire tree or other practices that destroy the broods, at a cost ranging from 75 cents to $5 per tree, depending on the size. It was hoped that these costs for treatment might be greatly reduced by some such method as that described.

Work was continued through 1926, 1927 and 1928. The results obtained were very conflicting. A high percentage of brood mortality occurred in some trees and with some chemicals, but in general the insects were killed only in a narrow strip above the point or points of injection. It was obvious that the idea might be practical but that the technique was poor; in other words, more thorough lateral distribution of the chemical was needed.

In the meantime several patents had been issued describing various methods of obtaining complete distribution of dye or preservatives in the tree. These were all too elaborate and expensive for the purposes intended. It occurred to the senior author that a combination of the technique already in use and the ringing practice used by orchardists to stimulate the setting of fruit buds might be more effective. Accordingly, during the summer of 1929 approximately two hundred trees were treated by the authors and R. W. Caird, the latter working chiefly on the physiological aspects of the problem.

The technique adopted was as follows.

(1) At a convenient working distance near the base of the tree the bark is first smoothed completely around the tree by the use of a wood rasp or draw knife to such a degree that it will permit a water-tight application.

(2) The next step consists in making a narrow (one eighth to one fourth inch) incision or notch completely around the circumference of the tree, by means of a saw or sharp knife, through the bark, and through two or more annual layers of wood, or through the entire sapwood, depending on the depth of penetration desired. This incision is located on that portion of the bark which has been smoothed.

(3) On one side of the tree an auger hole about

[1] Publication of the results obtained by the Bureau of Entomology at this time while the investigations are still in an experimental stage seems justified largely because a technique appears to have been developed which has some advantage over those previously described. It should be distinctly understood, however, that the Bureau of Entomology is not at this time advocating the use of this method for general application in the control of insects.

After this article had been prepared, Dr. Caroline Rumbold called our attention to the use of a somewhat similar technique by M. A. Boucherie, "Mémoire sur la conservation des bois," *Annales de Chimie et de Physique,*" 74: 113–157, 1840.

[2] J. Davidson and H. Henson, "The Internal Condition of the Host Plant in Relation to Insect Attack, with Special Reference to the Influence of Pyridine," *Ann. Appl. Biol.*, 16: 458–471, 1929; A. Muller, "Die innere Therapie der Pflanzen," Monograph angew. Ent. 8, pp. vi–206, illus., 1926 (abstract in *Rev. Appl. Ent.*, 14, Ser. A: 505); C. T. Rumbold, "The Injection of Chemicals into Chestnut Trees," *Am. Jour. Bot.*, 7: 1–20, 1920.

[3] C. B. Lipman and A. Gordon, "Further Studies on New Methods in the Physiology and Pathology of Plants," *Jour. Gen. Physiol.*, 7: 615–623, 1925.

[4] F. C. Craighead, "Interrelation of Tree-Killing Barkbeetles (Dendroctonus) and Blue Stains," *Jour. Forestry*, 26: 886–887, 1928; R. M. Nelson and J. A. Beal, "Experiments with Blue-stain Fungi in Southern Pines," *Phytopathology*, 19: 1101–1106, 1929.

one half inch in diameter and centering on the notch is bored into the tree to a depth of about one inch.

(4) Two methods have been used for making a water-tight connection around the tree. A strip of rubber band about two inches wide, such as old inner tubing, is stretched around the tree covering the notch and placed preferably so as to overlap at the point where the one half inch auger hole is bored. This bandage can be held by several nails or by wire tourniquets above and below. The other method consists in the use of an impervious plastic putty or waxlike material (grafting wax, asphaltum paste or tree gums) that will adhere readily to the bark. This method has advantages on trees of irregular circumference. Grafting wax has proved to be the most practical material tried.

(5) At a convenient distance, a few inches to a foot or more above the incision, a container is hung on the tree for the purpose of holding the liquid to be injected into the tree. This container is connected to the notch by means of a short section of rubber tubing terminating in a piece of metal pipe about one fourth inch in diameter. This pipe making contact with the container is connected to the circumferential notch through the one half inch auger hole and sealed by the plastic material used or by pushing it through the rubber bandage around the notch.

By means of this technique, from two quarts to several gallons of liquid, depending on the quantity required, can be injected into the tree in a few hours and thorough distribution obtained through all the outer annual rings severed and to the topmost branches and leaves. Two quarts was ample in most cases on the relatively small trees used. The quantity varies, depending on the concentration of chemicals employed and size of tree treated.

In general, the results were most encouraging. Complete brood mortality was obtained in practically all cases with certain chemicals, provided the application was made before the sapwood became blue-stained by associated fungi[4] and the ascending sap stream disturbed. The following table summarizes a few of the materials used, the quantities and the results obtained.

Although the writers have made no attempts to use dilute solutions with the idea of killing the insects and saving the tree, it is within the realm of possibility that with sufficient experimentation this objective could be attained. In the case of trees (conifers) that are more susceptible to this girdling of the cambium two or more breaks in the notch can be left on the circumference, which will greatly accelerate subsequent healing,[5] and the notches connected with

[5] This may not be necessary where grafting wax is used.

CHEMICAL SOLUTIONS USED IN TECHNIQUE DESCRIBED IN TREATING SHORTLEAF PINES INFESTED BY THE SOUTHERN PINE BEETLE AT ASHEVILLE, NORTH CAROLINA, 1929

Number of trees	Materials used in treatment*	Results of treatment: Number of trees in which the brood mortality was 100 per cent. and in which there was no blue stain (adults and eggs the only beetle stages present)	Results of treatment: Number of trees in which the brood mortality was only partial and in which there was blue stain (larval and more advanced beetle stages present)
17	Wood alcohol	10	7
11	Carbon disulphid and kerosene, equal parts	4	7
5	Copper sulphate and water, 50 grams	2	3
1	Ethylmonochloroacetate	1	0
7	Ethylene dichloride	3	4
4	Formaldehyde and water, 1 pt. 40 per cent.	2	2
25	Hydrocyanic acid and water, 5 per cent.	16	9
2	Mercuric chloride and water, 15 grams	2	0
32	Potassium cyanide and water, 30 to 50 grams	15	17
8	Sodium arsenite and water, 30 grams	4	4
7	Sodium fluoride and water, 30 grams	4	3
Total 119		63	56

* Average dosage, 2 quarts of solution for pine trees 5½ inches in diameter breast height and 30 feet high. The diameters of the trees ranged from 4 to 18 inches and the height from 20 to 60 feet.

a drill, or an additional container or attachment used with each notch. With most hard-woods the narrow saw cut completely encircling the tree will not cause death, but with conifers over 50 per cent. of the trees so treated as checks died.

Some tests have been made on the possibilities of utilizing this process for the injection of wood preservatives into the sapwood before felling the tree. Trees were treated with commonly used preservatives,

such as zinc chloride, copper sulphate, sodium fluoride and arsenicals, and the logs from these trees were set in the ground with untreated checks. Ordinarily in wood-impregnation processes only the sapwood is treated, to the depth of one inch or so. This method brings about the same results by use of forces within the living tree.

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SPECIAL ARTICLES

A GENERAL THEORY FOR CALCULATING SURFACE TENSION FROM THE SHAPES OF STABLE LIQUID SURFACES OF REVOLUTION

The general significance of Laplace's theory of liquid surfaces in the interpretation of all those methods for the determination of surface tension involving stable surfaces of revolution has not been commonly appreciated. The usual application of this theory has been through the integration of its differential equation by the use of particular assumptions. But these assumptions limit the generality of the underlying theory. In a few special cases, it is true, the theory has been applied without limiting assumptions, but even in these cases no hint has been given that the particular applications had general significance. Some methods are associated with this theory only empirically. It is the purpose of this note to state that all surface tension methods involving the use of stable liquid surfaces of revolution may be based upon the Laplace theory alone and that all of them thus are absolute methods in the sense that the value of the surface tension may be obtained from them without the use of limiting assumptions or the necessity for empirical comparison with another method.

The essence of this general method for calculating the value of the surface tension of a liquid is as follows. Draw, from the Laplace equation, the family of curves giving the shape of the surface assumed by the liquid in any of the experimental methods of this group; perform on this family of curves an operation analogous to the experimental procedure of any one of these methods, which gives a pair of corresponding quantities; construct from a number of such operations a curve one of whose coordinates is a dimensionless function of these quantities, while the other is a function the equivalent of which, for any particular liquid, involves its surface tension; and finally use this curve in connection with a measurement on the liquid whose surface tension is sought.

The shapes, though not the sizes, of liquid surfaces of revolution may be found by numerical integration of the equation expressing the Laplace theory:

$$\frac{du}{dx} + \frac{u}{x} = 2(h \pm y)$$

where the terms on the left may be considered as dimensionless ratios obtained by dividing the square root of the capillary constant of the liquid by the radii of curvature of the surface at any point, while that on the right is a ratio obtained by dividing by the square root of the capillary constant the height of a column of the liquid that would exert the pressure which exists at that point. To make this equation apply to any liquid, x, y, and h must each be multiplied by the square root of the capillary constant of that liquid, a. Numerical integration of this equation gives the various families of curves representing these surfaces, which fall into three groups which we have designated by the names meniscus, disk and drop profiles. From these families of profiles it is possible to derive a general theory for all the methods for the determination of surface tension which involve such surfaces.

An outline of our procedure by which relationships between the dimensionless quantities of the equation are used to calculate the value of the surface tension of a particular liquid will be given and illustrated by application to the capillary rise method. The first step is the preparation, from the equation, of a family of meniscus profiles, since this is the shape of the surface in a capillary tube. For the details of this step, which is rather involved especially when the data in the literature are not adequate, reference should be made to the papers mentioned below. In the second step the family of profiles is made to give the values of two dimensionless quantities, the analogues of which are measured in the experiment. In the capillary rise method these quantities are the radius of the tube and the height of the liquid in the tube between the undisturbed level of the liquid and the bottom of the meniscus. The analogous procedure is the selection of a particular value of x, which is equivalent to choosing a definite capillary and a definite liquid; the finding of that member of the meniscus family of curves which is tangent to the constant x line selected, the reading off of the value of the ordinate, y_0, of the point where this meniscus curve crosses the y-axis; and of the repetition of this procedure for other selected values of x. In the third step, from these pairs of corresponding values of x and y_0, a curve is constructed having for one coordinate a function of these quantities, whose identical function in the case of the analogous experimentally measured quantities is dimensionless, and for the other coordinate a function of x and y_0 whose equivalent function in the case of the analogous real quan-

tities must involve the capillary constant. In the capillary rise method the abscissa might conveniently be y_0/x which is dimensionless, and the ordinate y_0x whose analogue involves the capillary constant a^2 and so the surface tension. This curve is independent of any determination of surface tension and is applicable to all liquids. By means of these three steps the Laplace equation is now expressed in a form suitable for application to the measurement of the surface tension of an unknown liquid. In the capillary height method this fourth step is the determination of one pair of corresponding values of the radius, r, of a capillary tube and the height, h, of the liquid in it. From these the ratio h/r may be calculated which is the analogue of and equal to y_0/x. From this value of h/r and from the curve, the corresponding value of y_0x is read off. This must now be expressed in terms of similar quantities which are not dimensionless and which involve the characteristics of the particular liquid we are working with; that is, we must put back the capillary constant in the Laplace equation. This is the equivalent of saying that the y_0x read from the curve is equal, in the case of a particular liquid, to hr/a^2. Thus, knowing the value of y_0x from the curve and the values of h and of r from the experiment, the value of a^2 can be calculated.

For a detailed description of this procedure reference may be made to our application of it to the ring method for the determination of surface tension.[1] The scheme may be applied rigorously to all methods involving only stable liquid surfaces of revolution. We have indicated its application to the capillary height, bubble pressure and sessile drop methods, which involve meniscus profiles; to the pull on a disk and a sphere, which involve disk profiles; to the ring method, which involves both meniscus and disk profiles, and to various drop shape methods which involve drop profiles. The convenient and precise drop weight method, involving as it does a dynamic condition, does not come under this scheme.[2] Thus a single theory for all those methods of determining surface tension using stable liquid surfaces of revolution has been developed. Wherever the calculations based on the theory have been compared with the results of experiment, agreement has been observed within the limits of precision of the particular experiment. All these methods, we think, may therefore be considered absolute ones.

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[1] SCIENCE, 71: 345, 1930; *Jour. Am. Chem. Soc.*, 52: 1772, 1930.

[2] *Jour. Phys. Chem.*, 33: 1217, 1929.

"RIGHT-HANDEDNESS" IN WHITE RATS[1]

THIS report[2] is concerned with the problem of left- and right-handedness. The problem is one of biological, pathological and psychological interest. Biologically, we are interested in the origin, evolution and heredity of bilateral asymmetry which is expressed functionally in hand preference. Pathologically, the problem is often related to speech defect, facial paralysis, epilepsy and feeble-mindedness. Psychologically, we are interested in the acquisition, retention and modification of hand preference.

Statistical studies show that in human beings there are about 95 per cent. who are right-handed, whereas only 5 per cent. prefer to use the left hand. The question immediately arises as to why it is that the great majority of people are right-handed. Up to the present time there have been about five hundred articles published by various scientists to answer the question, but the solution of the problem still remains a mystery. We know very little as to why some people are left-handed while others are right-handed —as little as we know why some of the stars in the sky rotate on their axes from left to right while others rotate in the opposite direction.

However, various theories have been advanced to account for the phenomenon of hand preference. One theory says it is entirely a matter of habit. Now if it were entirely a matter of habit, we should expect that chances are fifty-fifty. We know that habit is formed through repetition. Repetition of what? Repetition of the initial accidental chance fixation. Now we have two hands. And if handedness were entirely a matter of habit, without any organic, environmental or social influence, then it is statistically logical that chances are fifty-fifty. To illustrate, Tsai has studied the ways people clasp their hands. Each person has his habitual way of clasping the hands. Some people clasp their hands with the left thumb uppermost, while others clasp with the right thumb on top. He found that this has nothing to do with handedness, but that the results turned out to be fifty-fifty. This can be very well explained by the theory of habit, which does not seem to account for the fact that 95 per cent. of people are right-handed.

The next theory says it is a matter of social tradition. When we are young, we are ambidextrous— and experiments show that it is true up to the age of about six months. Then society steps in and says, "Thou shalt use thy right-hand!" So we were trained by our parents to be right-handed in handling the fork or the chop-sticks, as the case may be, in shaking hands and in doing a thousand other things. But why

[1] Read before the Midwestern Psychological Association, May 23, 1930.

[2] From the Otho S. A. Sprague Memorial Institute and the departments of pathology and psychology of the University of Chicago.

is it that our parents train us to be right-handed? Well, it is because they are right-handed. Why is it that they are right-handed? It is because their parents were right-handed. So the question is pushed back to the primitive people. Archeologists, by studying the direction of the grooves produced by the flaking of stone implements, have come to the conclusion that the great majority of the prehistoric men were right-handed. The question is, "Why?"

The theory of primitive warfare maintains that prehistoric man was essentially a fighting creature. And in fighting he used his right hand for attack, because the left hand was reserved for holding the shield to protect the heart which he thought to be on the left side of the body. This sounds very interesting. But why is it that there are 5 per cent. left-handed people who can never be trained to be right-handed? Is it because their hearts are on the right side of the body?

Perhaps the best-known theory seems to be that we are right-handed because we are left-brained. It has been pointed out, though not experimentally proved, that when a person is right-handed he is also, in a less marked degree, right-footed, right-eyed and right-eared. In other words, he is right-sided. Now, the movements of the right side of the body are controlled by the left side of the brain. So this theory holds that for the majority of people the left hemisphere of the brain is more highly developed. Now more highly developed in what sense? Is it anatomical, physiological or chemical? The relative size and weight of the two hemispheres have been compared, the microscopic structures of the brains have been examined, the normal arching of the aorta artery has been reversed, but no definite results have been obtained. So the problem is still unsettled. In this connection, we may mention that we have been doing some work in comparing the relative distribution of water in the two hemispheres. Although the preliminary data seem to correspond very closely to the percentage of handedness, we are not ready to draw any conclusion pending the further results of our investigation.

As to the evolution of handedness, nobody has ever published anything beyond the primates. Practically all the work has been done on human beings with a very few exceptions on higher apes and monkeys. The conclusions thus far have been that infra-human animals are all ambidextrous and that handedness is the outgrowth of human intelligence. To quote Parson, in his book, "Lefthandedness," the first sentence of Chapter VI runs, "Since no authentic traces of handedness have been found among animals, even among the Quadrumana, we are forced to the conclusion that whatever the immediate anatomical or physiological cause may be, handedness itself is probably in some way the outgrowth of man's intellectual development." Now we find that even such a low animal as the white rat exhibits definite hand preference. The discovery was made by Tsai early in February, 1929, and a technique was soon developed by him for this particular investigation. The animal was put in a wire cage with a small glass bottle of wheat embryo inserted through the wire bottom. The opening of the bottle was so small (3/4 inch in diameter) that it permitted the rat to use only one hand at a time for grasping food out of the container. Since both the cage and the opening of the bottle were circular, there existed apparently no environmental situation tending to favor the use of either hand. Two hundred and fifty observations were made on each animal. They were distributed evenly over five days, with five series in a day. After each series, which consisted of the observation of ten consecutive hand movements, the animal was temporarily removed while the bottle was again filled up to the original level about half an inch from the brim. The criterion of handedness is that any rat using the left hand (or the right hand) from 75 to 100 per cent. of the total 250 attempts is considered to be left-handed (or right-handed as the case may be), while any rat using either hand from 50 to 74 per cent. of the total attempts is classified as ambidextrous. One hundred and fifty-nine rats have been thus studied. Among them, 105 were normal rats, while 54 were vitamin B depleted rats who suffered through the depletion of their mothers during the nursing period. The results for the normal rats are presented in Tables I and II.

TABLE I

Handedness in Normal Rats

Handedness	Relative frequency in percentage	
	59 males	47 females
Right	59	43
Left	26	37
Ambidextrous	15	20

TABLE II

Handedness in Normal Rats Excluding Ambidexterity

Handedness	Relative frequency in percentage	
	Males	Females
Right	69	54
Left	31	46

The results show that the majority of normal rats of either sex are right-handed. This discovery throws light on the phylogenetic evolution of handedness and at the same time overthrows the theory of outgrowth of human intelligence, the theory of primitive warfare and the theory of social tradition.

As to the heredity of handedness, the results in the literature are conflicting. Most investigators maintain that if handedness is hereditary at all, it does not seem to follow the Mendelian ratio. In order to study ten generations of human beings, a few hundred years are required. But with our discovery, we can attack the very same problem with better control in a short time.

As to the pathological significance of the problem, let us cite the following investigations. L. G. Smith found that among 2,055 school children, 4.5 per cent. of the girls and 5.5 per cent. of the boys were left-handed. Out of 500 delinquent, 6 per cent. of the girls and 11 per cent. of the boys; out of 200 feeble-minded, 11 per cent. of the girls and 8.5 per cent. of the boys were found to be left-handed. R. Ganter also reports that 21.9 per cent. of the epileptics and 18.7 per cent. of the feeble-minded are left-handed. In an earlier investigation, we found that normal rats are far superior in maze learning to those which have been depleted of vitamin B complex through their mothers' diet during the nursing period. It is therefore of interest to find out the distribution of handedness among the vitamin B depleted rats. The results for the depleted animals are presented in Tables III and IV.

TABLE III

HANDEDNESS IN VITAMIN B DEPLETED RATS

Handedness	Relative frequency in percentage	
	27 males	27 females
Right	48	33
Left	48	45
Ambidextrous	4	22

TABLE IV

HANDEDNESS IN VITAMIN B DEPLETED RATS EXCLUDING AMBIDEXTERITY

Handedness	Relative frequency in percentage	
	Males	Females
Right	50	43
Left	50	57

Comparison of the results indicates that the percentage of left-handedness is higher in the vitamin B depleted animals whose maze-learning ability was found to be much inferior to that of the normal rats. These results do not necessitate the conclusion that the left-handed are mentally inferior. They merely indicate that the percentage of left-handedness is higher among the poor learners, and that's all. Perhaps when we study a group of geniuses, we may find that the percentage of left-handedness is also higher. Professor McCollum, of the Johns Hopkins University, suggested that we study the members of the National Academy of Sciences or the "Who's Who in America." Of course the left-handed person may or may not be a genius, but he has certainly proved to be a great star in the baseball game.

As to the psychological aspects of the problem, Tsai has studied the time required by the animal to change from the direct method of eating with mouth to the indirect method of eating "from-hand-to-mouth." Also he has studied the amount of time required by each animal for making fifty consecutive attempts of hand movements a day. Both results, when plotted against five successive days, represent the abrupt curves of negative acceleration. As to the retention of hand-preference, he found that rats practically use the same hand after a month's interval. As to the modification of hand preference, we have not done anything. However, the experiment can be very easily performed. First put a rat in the cage and find out whether he is left- or right-handed. If he is left-handed, the next time he uses his left hand again give him a mild electric shock. See how much training is required and how long he will continue to use the modified hand. Besides, modification may also be achieved by paralyzing the preferred hand either with drug or operation, and the changes be studied during and after recovery.

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BOOKS RECEIVED

Chemical Engineering Catalog, 1930. 15th annual edition. Pp. 1168. Illustrated. The Chemical Catalog Company.

Forty-fifth Annual Report of the Bureau of American Ethnology, 1927–1928. Pp. 857. 29 plates. Smithsonian Institution.

GINZBURG, BENJAMIN. *The Adventure of Science.* Pp. xvi + 487. Simon & Schuster. $5.00.

MACLEOD, ANNIE L., and EDITH H. NASON. *Chemistry and Cookery.* Pp. xii + 545. 25 figures. McGraw-Hill. $3.50.

MANLEY, R. M. *Kinetic Space and its Speculative Consequences.* Pp. 93. 14 figures. R. M. Manley, Cleveland, Ohio.